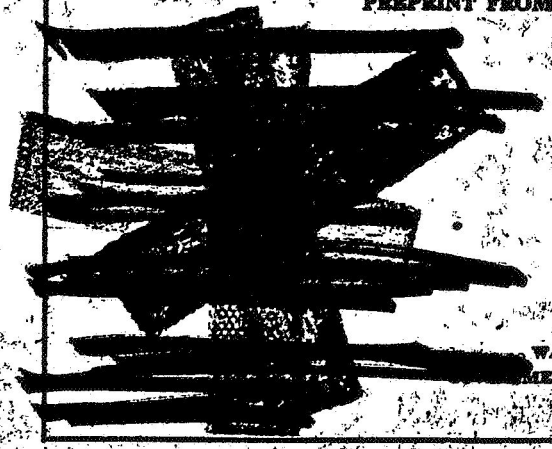
REPORT No. 67

SUPPLIES AND PRODUCTION OF AIRCRAFT WOODS

NATIONAL ADVISORY COMMITTEE
FOR AERONAUTICS

PREPRINT FROM FIFTH ANNUAL REPORT



WASHINGTON
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COMPILED BY

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U. S. Department of Agriculture

CONTENTS.

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SUPPLIES AND PRODUCTION OF AIRCRAFT WOODS

By W. N. SPARHAWK.

INTRODUCTORY.

The purpose of this report is to present in brief form such information as is available regarding the supplies of the kinds of wood that have been used or seem likely to become important in the construction of airplanes, and the amount of lumber of each species normally put on the market each year. A general statement is given of the uses to which each kind of wood is or may be put, but no attempt has been made to go into a technical discussion of these various uses.

The information herein contained has been compiled from a great many sources, including principally published and unpublished reports by various members of the Forest Service. Many of the figures given, particularly those relating to amounts of standing timber, are only crude estimates, but until we have a census of the forest resources of the country we shall have to depend largely on guesswork. The figures on production of lumber are taken from the annual lumber census reports and may be relied upon. Estimates as to the proportions of the total lumber production of different species that may be suitable for the manufacture of aircraft are necessarily very general, and are open to modification as methods of sawing or as airplane specifications change.

It is believed that all the species used to any extent or approved for use in American aircraft are included. However, specifications in all probability will be changed as the industry develops. Consequently, the use of many kinds of woods not now considered suitable may eventually be allowed.

Statements regarding the uses of the different woods are included in order to give an idea of the industries with which aircraft manufacturers will have to compete for their lumber supplies. The figures published were obtained several years ago and hence may not exactly represent present conditions, since the annual production of lumber of many of the species has changed considerably in the interval.

The maps that accompany the text show by dots the approximate locations of the mills that in 1917 produced the largest amounts of the lumber of most of the species covered. These maps, therefore, indicate in a general way the sources of commercial supplies of the various species.

SITKA SPRUCE.

(*Picea sitchensis.*)

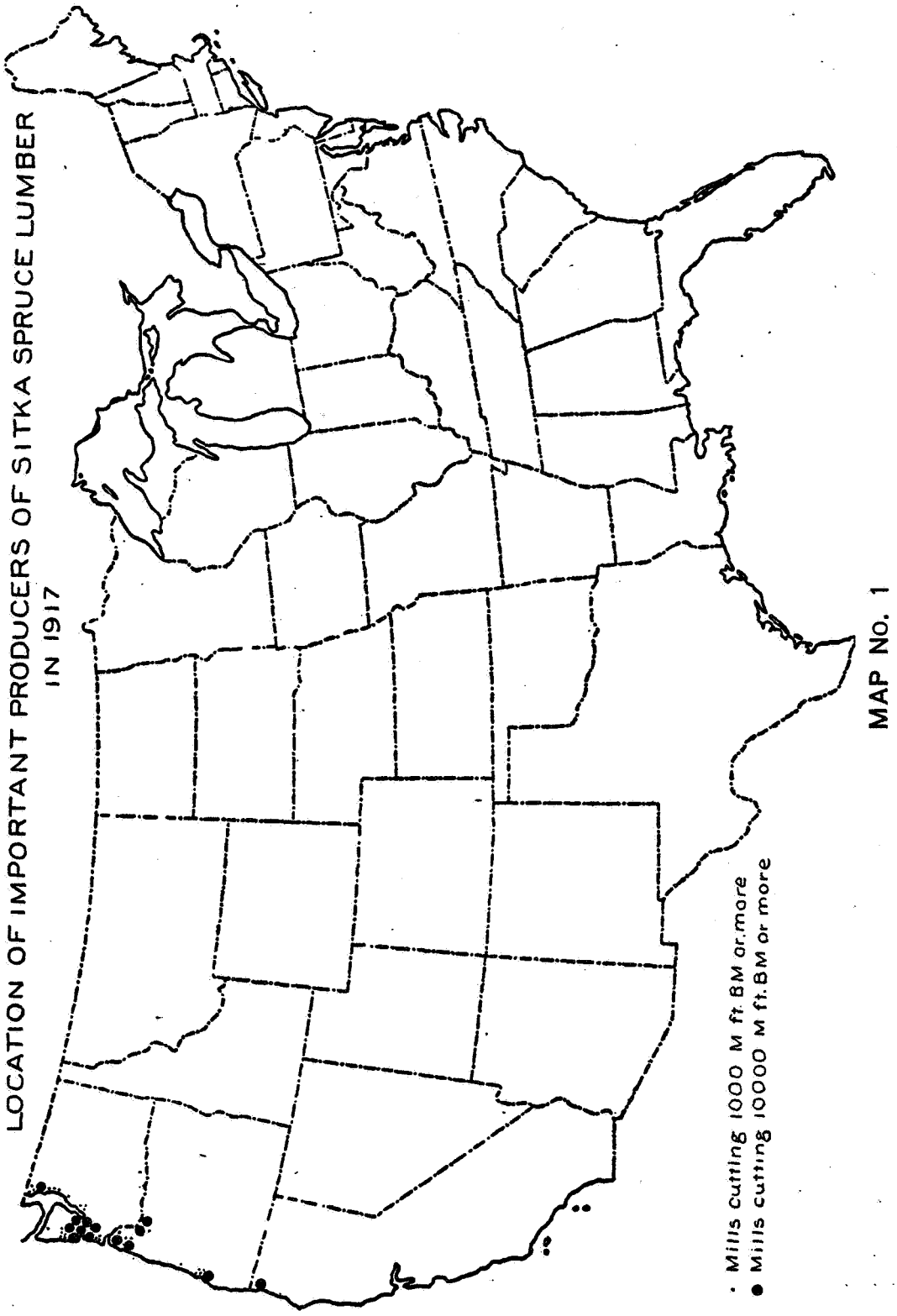
This species is also known as tideland spruce and western spruce.

DISTRIBUTION.

Sitka spruce occurs in a strip along the Pacific coast from northern California to Alaska. Only along a few of the larger valleys does it extend more than 40 miles inland. The bulk of the stand of high-grade spruce is in Clallam, Jefferson, Grays Harbor, and Pacific Counties, Wash., and in Clatsop, Tillamook, Lincoln, Douglas, Coos, and Lane Counties, Oreg.

USE IN AIRCRAFT.

Spruce is the wood par excellence for the construction of aircraft. It is light and has greater strength than other woods of similar weight. It is stiff, has a considerable degree of toughness, and can be worked with ease. These properties have made it the most generally used wood for wing beams and struts, and large quantities are employed for longerons, ribs, and plywood. Although there is no great difference in the strength properties of red, white, and Sitka spruce, the latter species on account of its greater size and consequently its larger proportion of clear lumber, is a more important source of aircraft material than the other two. Because of this and the large supplies of virgin timber still remaining, Sitka spruce will probably for many years be a very important species in the aircraft industry, notwithstanding the fact that the supply is so far away from centers of manufacture.


LOCATION OF IMPORTANT PRODUCERS OF SITKA SPRUCE LUMBER IN 1917
· Mills cutting 1000 M ft. B.M or more
● Mills cutting 10000 M ft. B.M or more
MAP No. 1

SUPPLY OF TIMBER.

Sitka spruce does not occur in pure stands over considerable areas, but grows in mixture with Douglas fir, western hemlock, grand fir, western red cedar, and associated species. It constitutes from 12 to 40 per cent, and occasionally an even greater proportion, of the stand on much of the land where it is found, with an average of about 20 per cent. The trees reach diameters of from 12 to 15 feet and heights up to 200 feet. Average mature trees are between 4 and 6 feet in diameter and contain from 10 to 15 thousand feet of lumber.

The total stand of Sitka spruce in Washington and Oregon is nearly 11 billion board feet,[1] of which 6,100 million feet is in the four Washington counties named above, 4,375 million feet in Oregon, and 475 million feet in other counties of western Washington. Except for about 600 million feet on the Queniult Indian Reservation, 950 million feet on the Olympic National Forest, and 700 million feet of State timber, all of which is in Washington, and 300 million feet on the Siuslaw National Forest, in Oregon, the spruce is privately owned, most of it by large timber and logging companies.

Almost all of the Government timber is at present inaccessible. One-third of the privately owned timber is scattered, inaccessible, or too low a grade to be important as a source of airplane material; 2½ billion feet is in large bodies which can be reached only by extensive road and railroad construction, and about 4 billion feet is fairly accessible to existing plants. The greater part of the spruce forests is in the more easily logged portions of the region, on the lowlands or in the lower foothills.

There is estimated to be from 15 to 18 billion feet of Sitka spruce in Alaska, practically all on National Forests, but only about 1 billion feet of this is good enough in quality to yield airplane lumber. There is also estimated to be about 29 billion feet in British Columbia, probably not of the highest quality.

PRODUCTION OF LUMBER.

The average annual cut of Sitka spruce lumber from 1913 to 1917 was 288 million board feet, of which three-fourths was cut in Washington. In 1917, 14 mills reported cuts of more than 10 million feet of spruce each, while about 30 mills cut from 1 to 10 million feet each. Small mills play a very unimportant part in the production of Sitka spruce.

Under normal conditions spruce is logged with other species as it comes in the stand. With the urgent demand for spruce during the war, however, the principle of selective logging was developed very generally, and special effort was made to get more spruce, and particularly higher-grade spruce, than would normally have been obtained. Because of the large size of the timber and the heavy stands, steam logging is in general practice, although in the selective logging animals were used to some extent. Motor trucks were used in addition to the logging railroads and water transportation in bringing logs to the mills. Logging operations in the spruce region are carried on throughout the year. In this region much of the timber is cut by logging companies that do not operate sawmills, but sell their logs to sawmills. Most mills saw logs of all species; a few specialize on spruce. Mills in the spruce region have a capacity considerably in excess of their normal total cut of all species. Until the demand for straight-grained material for airplanes developed during the past few years, no special effort had been made to saw that kind of lumber. The urgent demand for airplane material during the war led to improved methods of sawing, which made it possible to get the maximum amount of straight-grained lumber out of the logs.

Of the 7 billion feet which will yield airplane lumber, it is estimated that 20 per cent will grade No. 1 logs, 40 per cent No. 2, and 40 per cent No. 3. No. 1 and No. 2 logs should cut from 15 to 18 per cent of wing beam stock, and it is estimated that on the average the available mature spruce will yield between 10 and 15 per cent of wing-beam material. Of the total stand of Sitka spruce, probably between 7 and 10 per cent will be suitable for wing beams.

MARKETS AND USES FOR THE LUMBER.

Sitka spruce is used for about the same purposes as the other spruces. Forty per cent of the cut of spruce lumber of the United States is normally used for construction and other purposes without further manufacture. Sixty per cent is manufactured into a large variety of products. Planing mill products consume 26 per cent. The box and crate industry, which uses mostly the lower grades of lumber, takes 25 per cent, Musical instruments, which require the best material, especially for piano sounding boards, use 2.2 per cent. Woodenware employs 2.1 per cent, and many other industries use smaller quantities.

[1] It is estimated that about 1,600 million board feet of the most accessible Sitka spruce has been cut since this estimate was made.

Much of the high-grade Sitka spruce lumber is normally shipped east to the Central States, and construction material of this species has very recently begun to enter Atlantic coast markets in competition with eastern spruce. Shipments to foreign countries and to California markets usually go by water. Eastern shipments have gone by rail, but under normal conditions Atlantic coast shipments will probably take the water route.

EASTERN SPRUCE.

RED SPRUCE (*Picea rubens*). WHITE SPRUCE (*Picea canadensis*).

Picea canadensis is also known as cat spruce, bog spruce, and skunk spruce.

DISTRIBUTION.

Red spruce occurs from Prince Edward's Island, along the St. Lawrence Valley to central New York and Massachusetts, and along the mountains as far south as South Carolina. White spruce is found in northern New England, the Lake States, the Black Hills of South Dakota, and Montana, and extends far to the north in Canada and Alaska. In the United States, red spruce is commercially important in northern Maine, New Hampshire, and Vermont, and in the southern Appalachians from West Virginia southward. White spruce is important chiefly in the northern part of the Lake States.

USE IN AIRCRAFT.

Red and white spruce, with Sitka spruce, are the ideal woods for the structural parts of aircraft, because in them lightness and ease of working are combined with great strength, stiffness, and freedom from hidden defects. The three species do not greatly differ in strength properties, but Sitka spruce reaches much larger sizes and, therefore, produces a larger proportion of clear lumber suitable for aircraft. Spruce is used for wing beams, ribs, struts, longerons, plywood, and, indeed, for almost every wooden part of aircraft. Even though its place may be taken to some extent by other woods as the supply of virgin spruce dwindles, it will undoubtedly continue to be a very important aircraft material so long as wood is used for these purposes.

SUPPLY OF TIMBER.

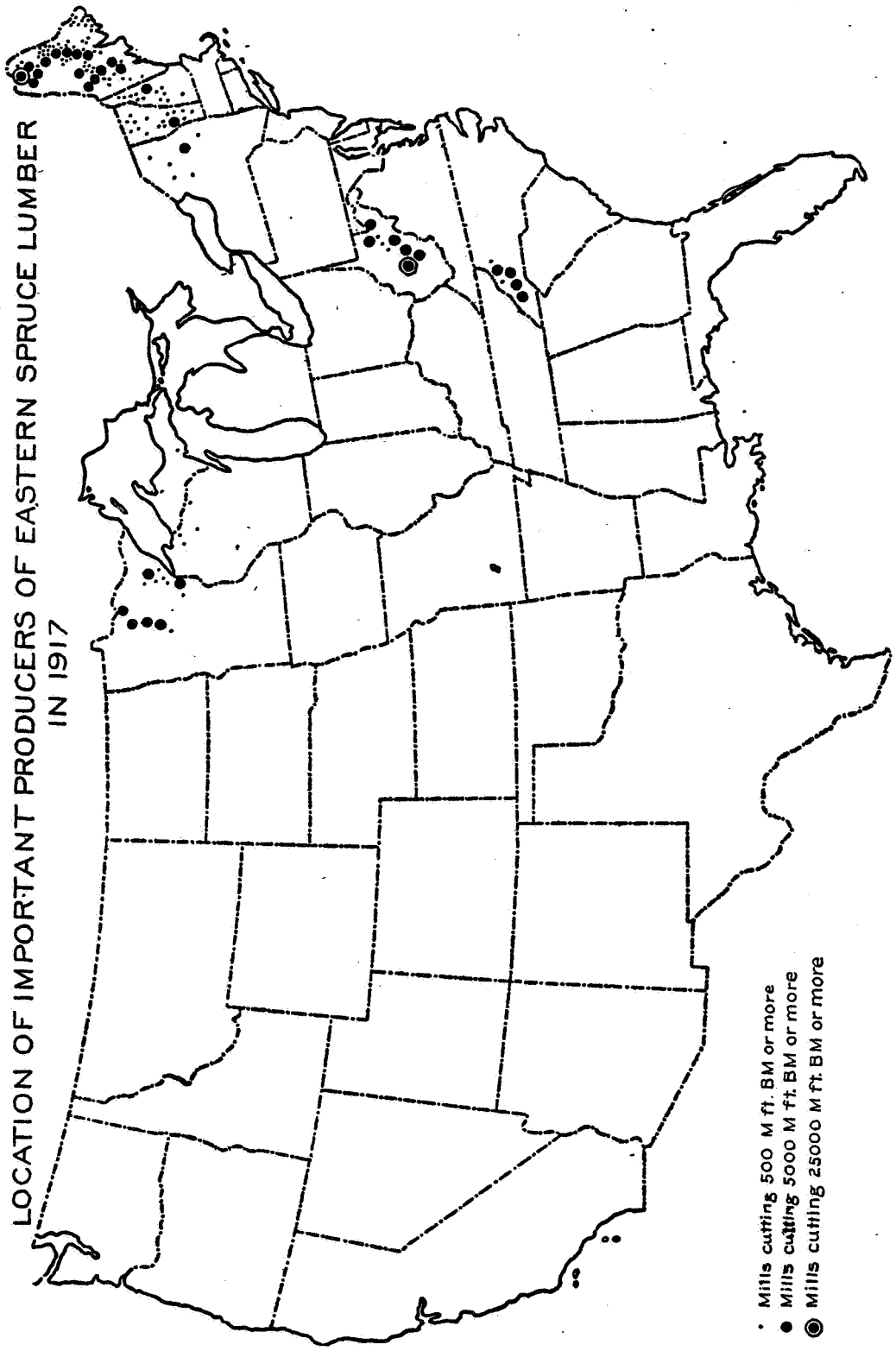
Spruce occurs at medium or high elevations, and in the northern part of its range it occupies lowlands also. In many places it forms extensive, pure or nearly pure, dense stands, especially in the more mountainous parts of its range. In other places it is found in mixed stands, with northern hardwoods (birch, maple, beech, and ash), as well as balsam, hemlock, tamarack, arbor vitæ, or even white and Norway pines. Over large areas, spruce makes up from half to three-fourths of the total stand. In the southern Appalachians spruce is confined to the higher mountains. The southern Appalachian section was not opened up until a comparatively recent date, but the spruce stands there are now being tapped by railroads and most of the better-grade spruce will soon be accessible to mills. The spruce in the Northeast must be transported to the mills principally on drivable streams. Although the topography of the region is such that the greater part of the lumber is accessible to such streams, still certain large areas are somewhat out of the way.

The northeastern spruce does not reach large size. While diameters of from 2 to 3 feet are not uncommon, a great many of the trees in mature stands have diameters between 12 and 18 inches. The southern spruce averages considerably larger than that of the North. It is doubtful whether the Lake States spruce will be used to a large degree for airplane lumber. The proportion of clear material produced is not large, and much of it is in short lengths.

The total stand of spruce saw timber in the eastern United States, excluding the Lake States, is approximately 14½ billion board feet. This estimate does not include trees less than 10 inches in diameter, and in some States does not include those less than 12 inches. Maine has approximately 7½ billion feet, New Hampshire 2 billion, Vermont 200 million, New York between 3½ and 4 billion, North Carolina and Tennessee 950 million, West Virginia and Virginia 390 million. Practically all of the old-growth spruce, as well as a large part of the second growth, is owned in large units by land, lumber, or pulp companies.

PRODUCTION OF LUMBER.

During the years 1913 to 1917, the average annual cut of spruce lumber in the Northeast and the southern Appalachians was a little less than 725 million board feet, of which 360 million was sawed in Maine, 65 million in Vermont, 70 million in New Hampshire, 25 million in Massachusetts, 45 million in New York, 105 million in West Virginia, and 50 million in North Caro-


LOCATION OF IMPORTANT PRODUCERS OF EASTERN SPRUCE LUMBER IN 1917
Mills cutting 500 M ft. BM or more
Mills cutting 5000 M ft. BM or more
Mills cutting 25000 M ft. BM or more

MAP No. 2

lina. While there is considerable fluctuation in the lumber cut from year to year, due partly to labor and weather conditions and partly to variation in the demand for spruce pulpwood, the general trend indicates a reduction in the cut of spruce lumber.

For the year 1917, 14 mills in Maine, 5 in West Virginia, 4 in North Carolina, and 1 each in New Hampshire, Vermont, and New York reported cuts of between 5 and 25 million feet of spruce, and 1 mill in Maine and 1 in West Virginia reported more than 25 million feet. About 90 mills, most of them in Maine, New Hampshire, and Vermont, cut between 500 thousand and 5 million board feet. While most of the spruce mills cut lumber of other species, spruce forms the major part of the cut of most of the larger mills. Existing mills, if they were run to capacity, could saw from three to five times as much spruce as they now cut.

In the Northeast, most of the logging is done in winter. Logs are hauled out to drivable streams by animals or steam log haulers. In the South operations are carried on throughout the year. In this region, both steam and animal logging is carried on, and logs are transported to the mills by railroad. Most operators cut spruce both for lumber and for pulp. Many of them saw only the best logs into lumber and let the small and inferior material go into pulp. During the past few years nearly all of the mill operators that cut any considerable quantity of spruce lumber have become familiar with the character of material required for aircraft and with the best methods of sawing it.

It is estimated that about 3.4 per cent of the spruce in Maine (12 inches in diameter and upward) will be suitable for airplane construction. Slightly more than 5 per cent of the New Hampshire and Vermont spruce, a little less than 5 per cent of that in New York, and from 8 to 8.2 per cent of that in the southern mountains will be suitable for airplanes. These figures do not in all cases represent what is being produced at the present time, because in some instances mills are now cutting material from the choicest parts of their tracts.

MARKETS AND USES FOR THE LUMBER.

Spruce lumber is used in large quantities for general construction purposes and by industries manufacturing wooden products. As is stated in the chapter on Sitka spruce, these industries use 60 per cent of the spruce lumber cut in the United States. High-grade spruce lumber is in great demand for piano sounding boards, for clapboards, and similar uses, and in shorter lengths for butter tubs. Eastern spruce is marketed mostly in the North and East and, consequently, does not have to carry heavy transportation charges. On account of the higher value of spruce stumpage in the East, together with such other factors as the larger percentage of upper grades sawed from Sitka spruce, the spruce from the Northwest is now competing with the native lumber even on the New England market.

Some 10 to 15 million feet of eastern spruce lumber is exported in normal times, chiefly to the countries of western Europe.

DOUGLAS FIR.

(*Pseudotsuga taxifolia.*)

This species is also known as red fir, yellow fir, Oregon pine, red pine, and Douglas spruce.

DISTRIBUTION.

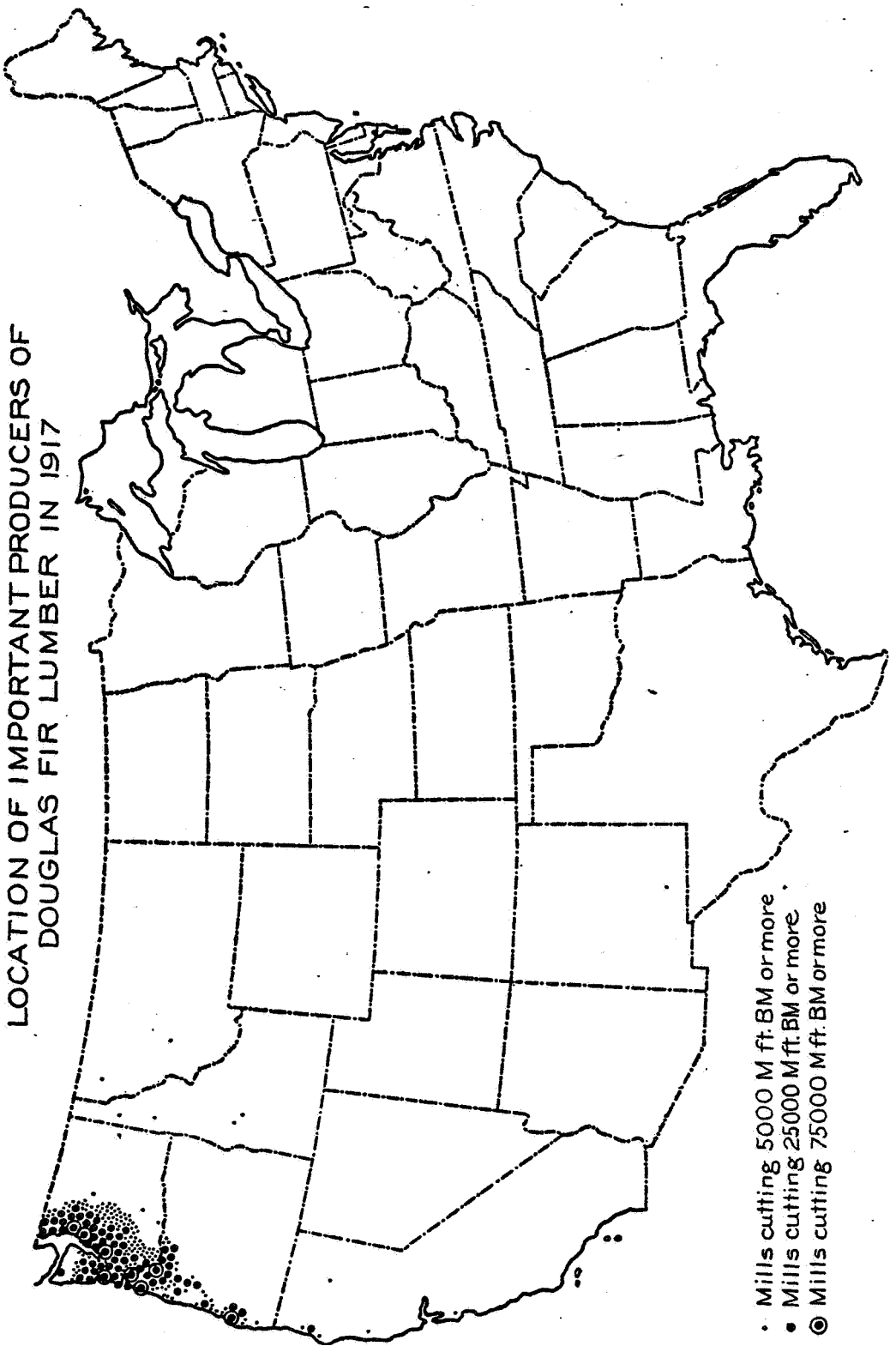
Douglas fir occurs through most of the forests from the Rocky Mountains to the Pacific coast, and from Mexico to central British Columbia. Only the stands west of the Cascade Range, from northern California to British Columbia, contain any considerable proportion of material suitable for aircraft construction, and, therefore, only the fir from this region is covered in the following discussion.

USE IN AIRCRAFT.

Douglas fir is a very satisfactory substitute for spruce in making wing beams, longerons, struts, and engine bearers, and has been so used to a considerable extent. While somewhat heavier than spruce, and more liable to check and shake during manufacture and in service, in its strength properties it is equal or superior to spruce of the same sizes. The enormous supply available, the large proportion of high-grade material, and the high degree of development reached by the lumber industry in the Douglas fir region make this species an important source of airplane material.

SUPPLY OF TIMBER.

Douglas fir is the predominant tree through most of the forest area west of the Cascade Range in Oregon and Washington, and in many places it covers extensive areas practically to the exclusion of other species. It forms very heavy stands, averaging from 30 to 60 thousand board feet per acre over large tracts, and reaches large sizes. The trees in virgin stands average


LOCATION OF IMPORTANT PRODUCERS OF DOUGLAS FIR LUMBER IN 1917
· Mills cutting 5000 M ft. BM or more
• Mills cutting 25000 M ft. BM or more
◉ Mills cutting 75000 M ft. BM or more

MAP No. 3

from 3 to 6 feet in diameter and from 150 to 200 feet in height, and many are much larger. While the species grows from sea-level up to 6,000 feet elevation, the stands of better quality that will yield a fair proportion of aircraft material are mostly below 3,000 feet and offer no obstacles to logging operations. Large bodies of timber are accessible to existing mills and others will be opened up as they are needed. The stand of Douglas fir timber in the region under consideration is estimated at approximately 600 billion board feet, of which 60 per cent is in Oregon and 40 per cent in Washington. Of this, 100 billion feet is on the national forests, 30 billion on State and Indian lands, and 470 billion in private holdings, for the most part in large tracts.

PRODUCTION OF LUMBER.

The annual cut of Douglas fir lumber in the United States, from 1913 to 1917, inclusive, has averaged 5,150 million board feet, and is steadily increasing. The southern yellow pine forests, which now furnish the great bulk of the country's construction material, have passed the crest of their production, and the Douglas fir region will soon be called upon for an increasing production to fill the gap. Ninety-five per cent of the cut comes from Oregon and Washington, and more than 80 per cent of this, or approximately 4 billion feet, from west of the Cascades. All but a comparatively insignificant part of this is produced by large, well-equipped, up-to-date mills, of which there are about 180. Their rated capacity on a one-shift basis is between 9 and 10 billion board feet a year or, allowing for other species cut along with the fir, about double their present output.

Because of the large sizes of the timber, steam logging and railroad hauls are the rule. Logs are ordinarily cut from 32 to 40 feet long. Stands are generally cut clear of all merchantable material, taking all species as they come. Operations are continued throughout the year. Many logging companies have no mill connections but sell their logs to sawmills.

Under normal conditions no particular effort is made to saw out straight-grained lumber. The demand for such material during the past two years led to the development of methods for producing it, and these will no doubt be continued and improved upon if the demand continues.

Under present standards most of the airplane material will come from the grades No. 2 clear and better. The percentage of the cut in these grades varies with different stands, but for the region averages about 20 per cent. It is estimated that half of this lumber will not be suitable for aircraft, on account of low density, pitch pockets, and a little spiral grain. The other half, or 10 per cent of the total cut of 4 billion feet, should be suitable for aircraft, and probably 60 per cent of that, or 6 per cent of the total cut, will meet present standards for wing beams.

MARKETS AND USES FOR THE LUMBER.

Of the total cut of Douglas fir lumber, approximately 45 per cent, including most of the better-grade material, is further manufactured. The greater part, 40 per cent of the cut, goes into flooring, interior finish, sash and doors, and other planing mill products. Between 15 and 20 per cent of all wood used for these purposes in the United States is Douglas fir. Of the total cut, 1.8 per cent goes into tanks and silos, 1.7 per cent into cars, and 0.9 per cent into ships and boats. Considerable quantities are used for pumps and pipe, furniture, boxes and crates, fixtures, paving, rollers, agricultural implements, and woodenware.

Douglas fir is being sold in increasing quantities in the eastern United States. It has for a number of years been exported in considerable quantities to South America, China, and Australia, and to a very limited extent to European countries.

PORT ORFORD CEDAR.

(*Chamaecyparis lawsoniana.*)

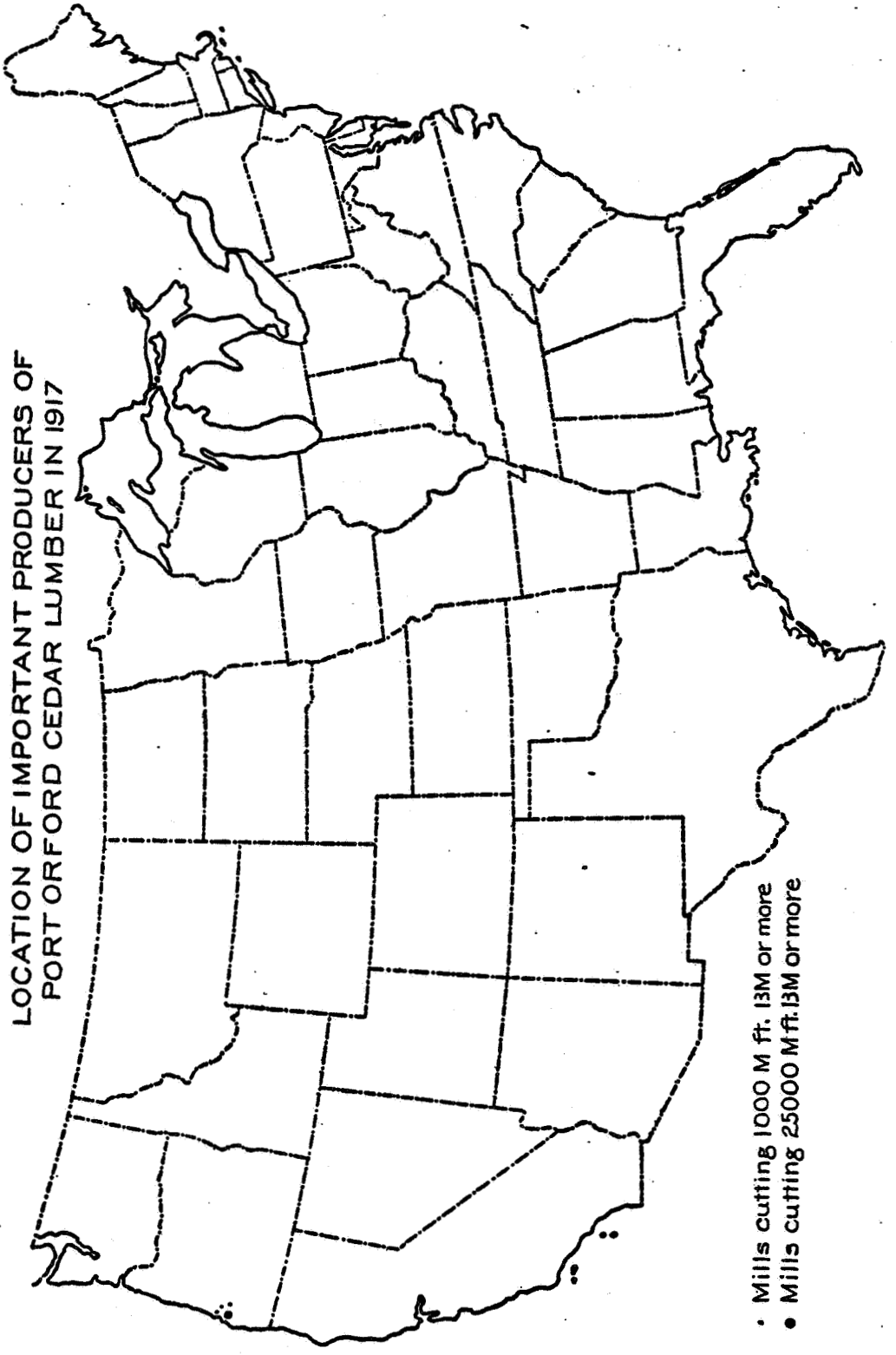
This species is also known as Lawson cypress, Oregon cedar, and white cedar.

DISTRIBUTION.

Stands of Port Orford cedar of commercial importance are confined to a strip from 20 to 25 miles wide along the Pacific coast in Coos and Curry Counties, Oreg. Scattered individuals are reported as far south as the Klamath River and Mt. Shasta, in California.

USE IN AIRCRAFT.

While somewhat heavier than Sitka spruce, Port Orford cedar is equal or superior to spruce in all its strength properties, and has been successfully used as a substitute for spruce in making wing beams and for other uses to which spruce is adapted. While this species is satisfactory for aircraft use, the limited supply and small annual output indicate that it will probably not play a very important part in the future development of the airplane industry.


LOCATION OF IMPORTANT PRODUCERS OF PORT ORFORD CEDAR LUMBER IN 1917
• Mills cutting 1000 M ft. BM or more
• Mills cutting 25000 M ft. BM or more

MAP No. 4

SUPPLY OF TIMBER.

Port Orford cedar does not grow in pure stands, but is scattered through forests of Douglas fir, hemlock, grand fir, and western red cedar. It usually comprises from 25 to 30 per cent of the stand. Trees of this species reach very large size. Practically all of the standing Port Orford cedar is virgin timber, and fairly accessible to existing mills. The stand is estimated at about 750 million feet, of which 250 million feet is on the Siskiyou National Forest, and the remaining 500 million feet, about equally divided between Coos and Curry Counties, is privately owned. Most of this is in the hands of a small number of large firms.

PRODUCTION OF LUMBER.

The total cut of Port Orford cedar in 1917 was about 35 million board feet, which is probably about the average annual production. The bulk of it is cut by one firm and only four mills cut more than one million feet each. Cedar is ordinarily cut as it comes in the stand, and makes up about 28 per cent of the total cut of the mills which produce it. Existing plants, if run to full capacity on a one-shift basis, could cut approximately 25 per cent more than they did in 1917.

Logging is by steam, and log lengths of from 32 to 40 feet are commonly cut. During the drive for wing-beam material for the war, sawing methods adapted to the maximum production of straight-grained material were used; but, since straightness of grain is not one of the main considerations in cutting lumber for most commercial uses, it is possible that no special effort will be made to produce that kind of material in the future.

About 20 per cent of the cut falls in the clear grades (No. 1 and No. 2), and it is estimated that 60 per cent of this or 12 per cent of the total cut, is of airplane grade. The other 40 per cent will be disqualified on account of low density, spiral grain, or other defects.

MARKETS AND USES FOR THE LUMBER.

The upper grades of Port Orford cedar are used for interior finish, caskets, and boat building. The lower grades go into general construction. Much of the output is normally used on the Pacific coast, and some is exported to Japan.

FIR.

GRAND FIR (*Abies grandis*).

This species is also known as lowland white fir, white fir, Oregon white fir, and silver fir.

SILVER FIR (*Abies amabilis*).

This species is also known as lovely fir, amabilis fir, red fir, red silver fir, and larch.

NOBLE FIR (*Abies nobilis*).

This species is also known as larch, and red fir.

WHITE FIR (*Abies concolor*).

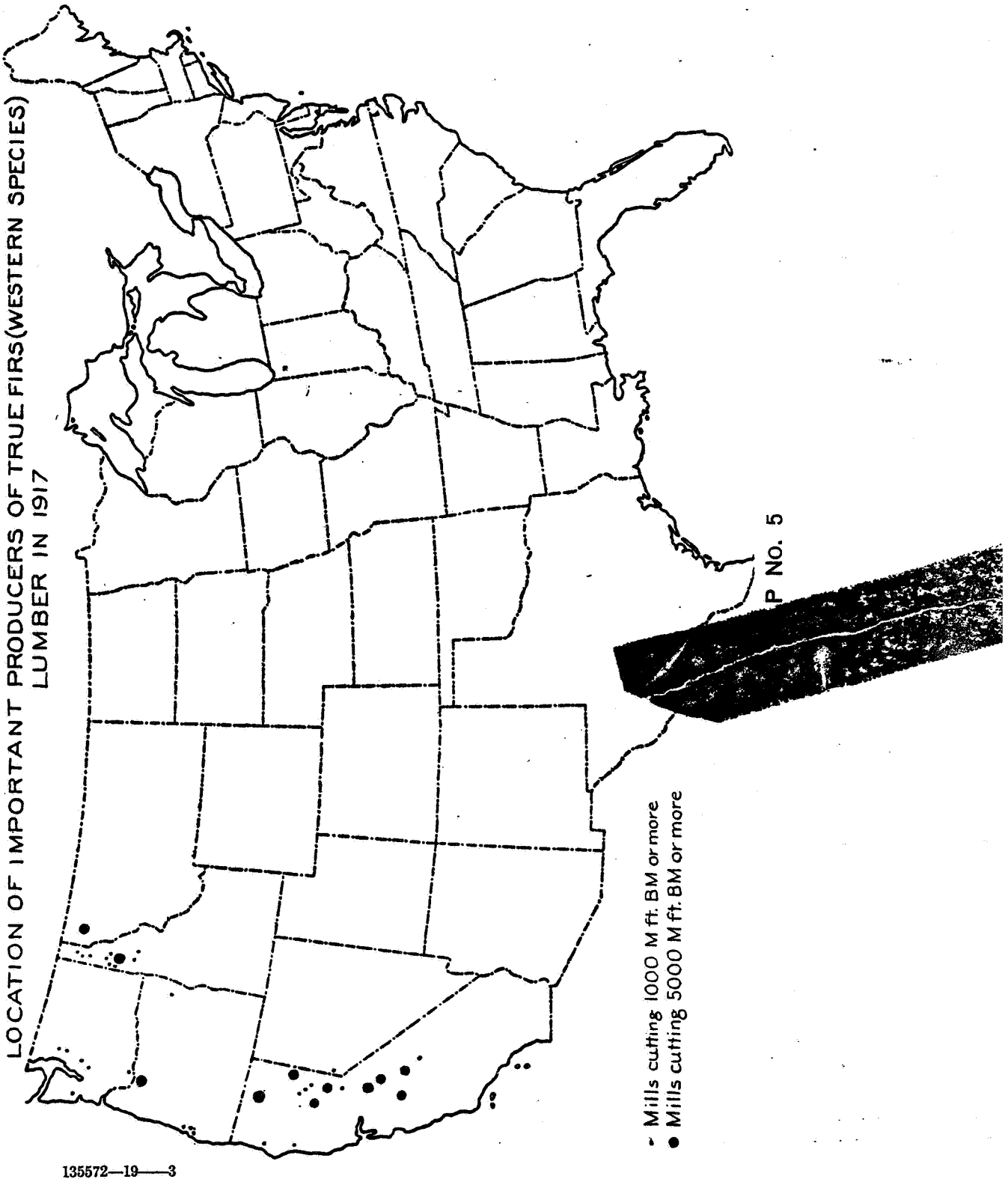
This species is also known as California white fir, Colorado white fir, balsam, and silver fir.

DISTRIBUTION.

Grand fir occurs along the Pacific coast and along the Cascade range from Vancouver Island to northern California, and extends into northern Idaho and northwestern Montana. Silver fir occurs on the upper slopes of the Cascade and Coast Ranges from British Columbia to central Oregon, and is most abundant in the Olympic Mountains of Washington. Noble fir also occurs on the Coast Ranges of Washington and Oregon, and along the Cascades of northern Oregon and southern Washington. The range of white fir extends from the Rocky Mountains of southern Colorado to northern Oregon, and southward through California to New Mexico, Arizona, and northern Mexico. It is of large commercial importance only in the Sierra region of California.

USE IN AIRCRAFT.

Grand fir is somewhat heavier than spruce, but in strength compares favorably with it. Silver fir is also slightly heavier than spruce, but practically equal to it in most of its strength properties. Noble fir is lighter than spruce, and about as strong. White fir is a little lighter than spruce, and almost as strong, except in shock resistance. While the firs have not so far been used to any extent in airplane construction, at least the first three species named may prove to be fairly satisfactory substitutes for spruce in making wing beams and struts. As far as present information shows, the other firs are not strong enough for such use. Because of their light weight, however, the firs are suitable for core work in producing plywood.


LOCATION OF IMPORTANT PRODUCERS OF TRUE FIRS (WESTERN SPECIES) LUMBER IN 1917
• Mills cutting 1000 M ft. BM or more
● Mills cutting 5000 M ft. BM or more
P No. 5

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SUPPLY OF TIMBER.

The firs usually occur in mixed coniferous forests, although in some situations they form practically pure stands over considerable areas. Associated species in the northwest coast region are Douglas fir, western hemlock, western red cedar, Sitka spruce. In the Montana-Idaho region the stands include western white pine, Douglas fir, western red cedar, western larch, western yellow pine, western hemlock. The white fir in the Sierra region is associated with western yellow, Jeffrey, and sugar pines, Douglas fir, red fir, incense cedar, and occasionally with the bigtree. Grand fir occurs chiefly at low and medium elevations, and there it can conveniently be logged along with Douglas fir and its other associates. Silver fir is a tree of the higher slopes, and very little of it can be considered accessible under present conditions. The same is true, but to a somewhat less extent, of noble fir. White fir grows in rough mountain country, and much of it is hard to get at. It is commonly taken when found on tracts that are being cut over primarily for other species.

The total stand of grand fir is estimated at about 13½ billion board feet, of which nearly 5 billion feet is in Washington, 4 billion feet in Oregon, and 4½ billion feet in Idaho and Montana. Two-thirds of it is owned by the Government, principally on National Forests; the rest is owned by lumber and timber companies. It is estimated that there is 35 billion feet of silver fir, and that 32 billion feet of it is in Washington, owned about half-and-half by the Government and by private companies. Of the 4 billion feet of noble fir, two-thirds is owned by the Government and one-third by private concerns. Three billion feet of it is in Oregon. There is about 35 billion feet of white fir in California, 5 billion feet in Oregon, and possibly 1½ billion feet scattered in other States. About half of it is on the National Forests and the other half is in the hands of large private owners.

PRODUCTION OF LUMBER.

The average annual cut of all species classed as "white fir," which includes the four species under discussion, as well as red fir (*Abies magnifica* and *A. shastensis*) and alpine fir (*A. lasiocarpa*), was about 110 million feet a year up to 1916. Of this it is estimated that approximately 45 million feet each were white fir and grand fir, and between 5 and 10 million feet each noble fir and silver fir. With rising prices, which made it possible to log more of the fir, the cut rose in 1916 to about 190 million feet, and slightly exceeded that amount in 1917. The cut of grand fir is estimated to be now about 64 million feet, of which 53 million comes from northern Idaho and adjacent parts of Montana and Washington; that of silver fir is judged to be about 8 million [illegible] Washington; that of noble fir, 6 million feet, cut by one firm; and that of white fir, [illegible] million feet, of which 87 million feet is cut in California and 11 million feet

[illegible] of this lumber, probably at least 90 per cent of it, is produced by large [illegible] only incidentally as it comes in the run of logs. Thirty mills report cuts for 1917 of between 1 and 5 million feet of fir, and 11 report cuts in excess of 5 million feet.

Steam logging is very general in the fir region, and nearly all operators use logging railroads. In the northwest coast region logs are cut long, while in the northern Idaho region and in the Sierras 16-foot lengths are the rule.

Since, with the exception of the noble fir, the logs make only relatively low-grade material, little care is used at most mills in sawing them up. The percentage of clear material that can be obtained varies rather widely in different localities. The best available estimates indicate that about 1 per cent of the white fir and grand fir, from 1 to 2 per cent of the silver fir, and 10 per cent of the noble fir will be suitable for airplane construction.

MARKETS AND USES FOR THE LUMBER.

The great bulk of the fir lumber produced is used in construction work without further manufacture. The best material is made into flooring, sash, doors, interior finish, and shelving. The box and crate industry uses a small percentage of the output. While some fir lumber may reach eastern markets along with shipments of Douglas fir and western pine, by far the greater part of it is used in the West.

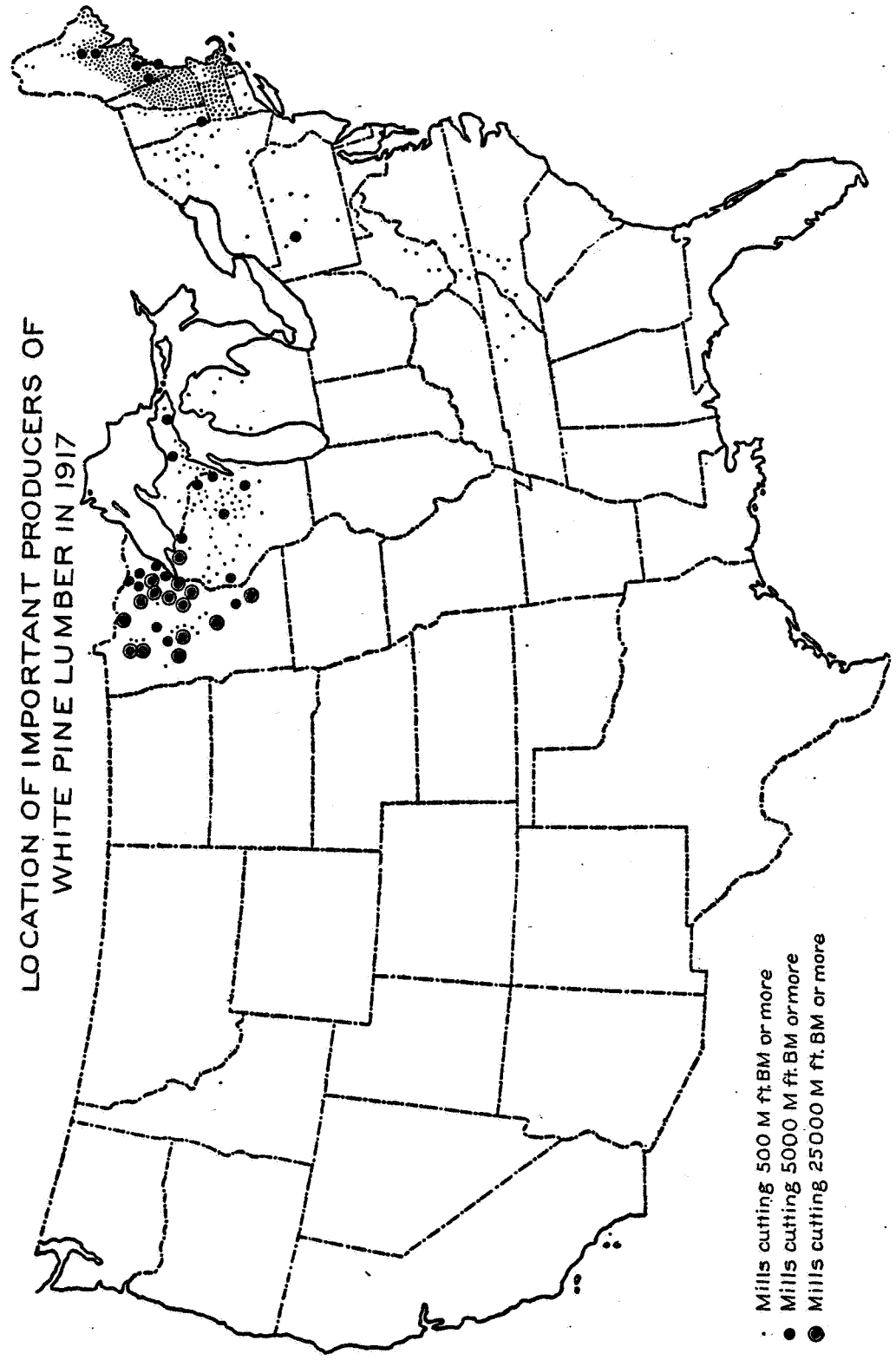
WHITE PINE.

(*Pinus strobus.*)

This species is also known as Weymouth pine, northern pine, spruce pine, and soft pine.

DISTRIBUTION.

White pine occurs from Newfoundland to Lake Winnipeg, and southward through the Lake States, the New England States, and in the Appalachians as far south as northern Georgia.


LOCATION OF IMPORTANT PRODUCERS OF WHITE PINE LUMBER IN 1917
Mills cutting 500 M ft. BM or more
Mills cutting 5000 M ft. BM or more
Mills cutting 25000 M ft. BM or more

MAP No. 6

USE IN AIRCRAFT.

Although somewhat softer, less shock-resistant, and less stiff than spruce, white pine is comparatively strong and light, uniform in structure, easy to dry and work, and stays in place well. It is a fairly satisfactory substitute for spruce in making wing beams and for other uses, and has been so employed. Because of its lightness, it makes excellent cores for plywood. Norway (or red) pine (*Pinus resinosa*), which is cut and marketed along with white pine in the northern part of its range, may also be used as a spruce substitute.

The remaining supply of virgin white pine is fast disappearing; and, since very little wing beam material can be obtained from second-growth, this species will not long continue to be an important airplane wood, except possibly for plywood.

SUPPLY OF TIMBER.

Pure stands of white pine or mixed stands of white and Norway pine still cover extensive areas in Minnesota. Other areas are covered with mixed stands of pine, hardwoods, and hemlock, in which pine may or may not be the predominant species. There are practically no virgin pine stands left in the Northeast. Most of the pine in this region is now in small tracts, many of which are pure pine, while others contain pine in various mixtures. While these stands are frequently heavy, they contain very little clear material suitable for wing beams and similar uses. The virgin white pine in the Appalachian region is now chiefly in the South, from West Virginia southward. In this region it occurs scattered through mixed hardwood and hemlock stands, and its average quality is not so high as is that of the pine in the Lake States. Virgin white pine averages 3 feet and more in diameter and 100 feet or more in height.

Only the supply of virgin timber need be considered in discussing wood suitable for aircraft construction. This is roughly estimated at 12 billion board feet, of which 10 billion feet (25 per cent of it Norway pine) is in the Lake States (chiefly in northern Minnesota), and 2 billion feet in the southern Appalachians. It is practically all on large tracts owned by land and lumber companies, and most of it is accessible and available for existing mills.

PRODUCTION OF LUMBER.

From 1913 to 1917, the average annual cut of white pine lumber was nearly 2,100 million feet, as against an average of about 3,500 million feet during 1907 to 1912. The white pine cut has been steadily falling off for a number of years as the supplies of virgin timber have become more nearly exhausted. It may be expected to continue to fall rapidly until the few billion feet left in Minnesota are cut, after which a fairly constant amount will be cut each year from second-growth stands.

Of the present cut, a little more than half, or about 1,200 million feet, comes from virgin timber. About 900 million feet of this is cut in Minnesota, 210 million feet in Wisconsin and Michigan, and 75 million feet in the southern Appalachians. Small amounts of virgin white pine are cut in Maine, Pennsylvania, and New York. Ninety per cent of the virgin pine is sawed by large mills, a number of which cut 25 million feet or more a year. Fourteen mills in Minnesota and one in Wisconsin reported cuts of this size in 1917. These mills cut white and Norway pines principally; some of them cut little of any other species. In the South, white pine usually forms only a minor part of the cut of the mills that produce it. The second-growth pine of the Northeast is almost entirely cut by small stationary or portable mills. Some 350 operators in New England reported cuts in 1917 of between 500 thousand and 5 million feet, and only six reported cuts in excess of 5 million feet. Lake States mills have a total capacity far in excess of their present output.

Logging in the Lake States pine region is mostly done in the winter, since surface conditions favor hauling when the ground is frozen. In the Appalachians logging is carried on throughout the year. Most operators use animals, and cut few logs more than 16 feet long, except of Norway pine, which is frequently cut 18 and 20 feet long. The larger operators use logging railroads.

Straight grain is a characteristic of white pine, and little effort is necessary to produce material of that quality. It is estimated that 85 per cent of the material graded B Select and better, or from 50 to 60 per cent of that graded D Select and better, will be suitable for airplane use. In the Lake States region about 14 per cent of the cut from old stands is D and better, which would make from 7 to 8½ per cent of the cut suitable for aircraft, if it were cut in the proper sizes. In the Appalachians probably not more than 4 per cent of the cut would be satisfactory.

MARKETS AND USES FOR THE LUMBER.

White pine, once the most widely used lumber in the United States for general construction and other purposes, has come to be more and more a wood for special uses, and only a very small part of the cut is now used in its rough form. Half of the total cut goes into planing mill

products—sash, doors, blinds, siding, and similar articles, which require fairly high-grade material. Nearly two-fifths is used by the box and crate industry, which, at least until the last few years, used white pine more than any other wood. This industry uses chiefly low-grade lumber. Considerable quantities of upper-grade white pine are used not only in ship and boat building, but also for patterns, tanks, silos, furniture, and musical instruments. Upper grades of Norway pine go into planing mill products, ladders, and cars.

White pine reaches a somewhat extended market; but, now that it is largely used by manufacturing industries, a great part of it is sold in the Northern and Eastern States. Facilities for shipping are good, for most of the large mills are so located as to be able to transport their output either by rail or by water.

WESTERN WHITE PINE.

(*Pinus monticola.*)

This species is also known as Idaho white pine, mountain pine, and silver pine.

DISTRIBUTION.

While the range of this species extends from southern British Columbia to western Montana and south along the Cascades and Sierras to central California, the region of its great commercial importance is in the Panhandle of Idaho and in adjacent parts of Montana and Washington.

USE IN AIRCRAFT.

While slightly heavier than spruce, western white pine compares very well with it in all strength properties except hardness. It makes a fairly satisfactory substitute for spruce for wing beams and similar uses. It is also a good material for plywood cores because of its comparative lightness. However, because of the relatively small percentage of the cut that is available for airplane use, and because of the abundance of other woods suitable for the same purpose, it is likely that western white pine under normal conditions will not be a very important source of material for the manufacture of aircraft.

SUPPLY OF TIMBER.

Western white pine occasionally appears in pure or almost pure stands on limited areas, but is more commonly found in mixture with western hemlock, western red cedar, western larch, Douglas fir, grand fir, and lodgepole pine. In the region of its best development it occurs at low and middle elevations, but in the coast region it is more a tree of the higher elevations, where, however, it usually constitutes only a very insignificant proportion of the stand. The tree reaches a fairly large size, with diameters frequently in excess of 5 feet and heights from 100 to 150 feet at maturity. Larger sizes are not uncommon.

Logging conditions are not equally favorable everywhere in the white-pine territory, and a large portion of the stand as yet is somewhat inaccessible, but it is estimated that from 15 to 20 per cent of the stand is available to existing mills.

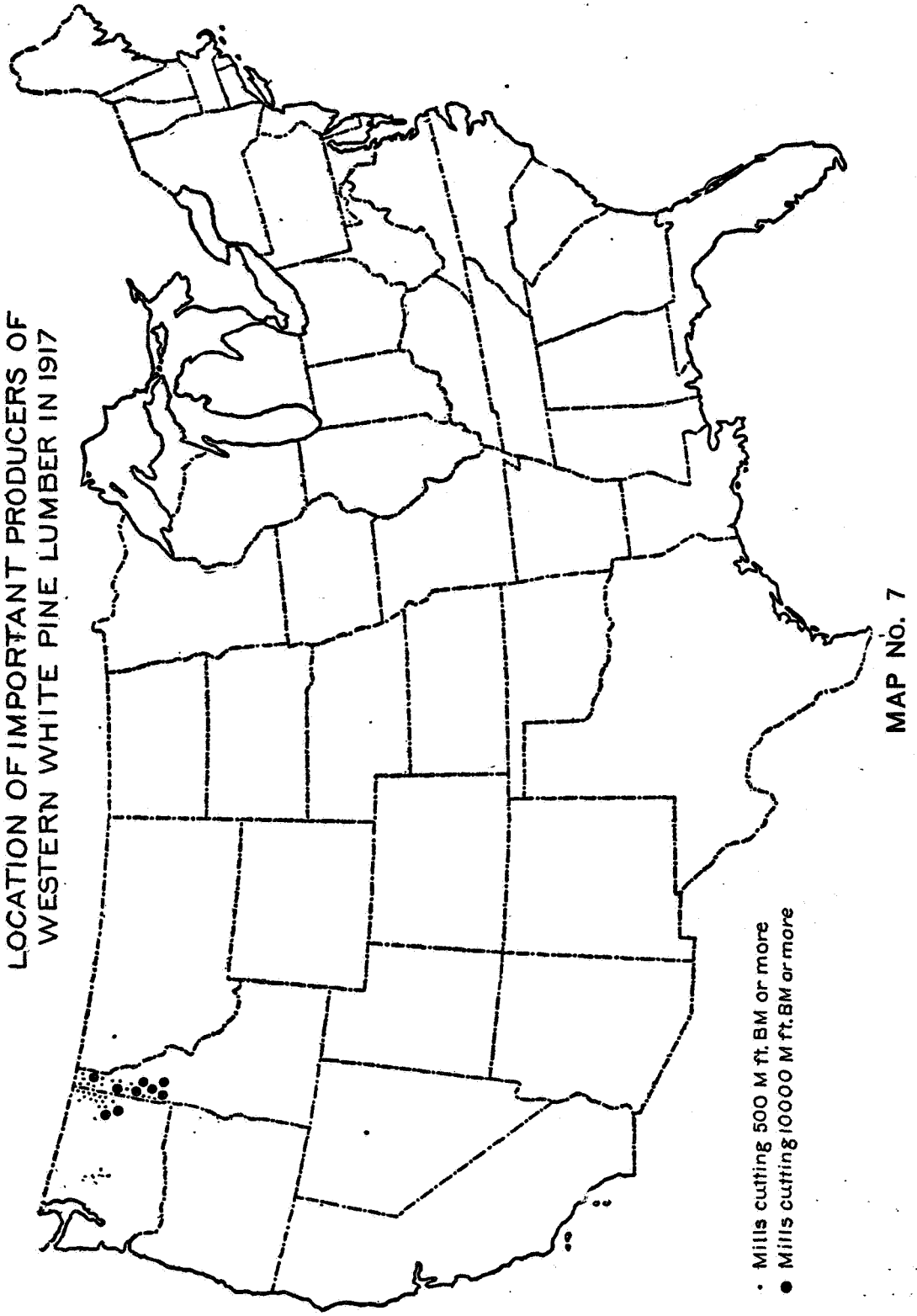
The total stand has been estimated at about 29 billion feet, of which 6½ billion feet is on National Forests, 3 billion feet is owned by the States (principally Idaho), and 19½ billion feet is held by private interests, mostly in large holdings of lumber companies or railroads. The greater part of this is in northern Idaho and the northeast corner of Washington.

PRODUCTION OF LUMBER.

The average annual cut of western white pine between 1913 and 1917 was 350 million feet, and the general tendency indicates a slight increase, except that abnormal conditions during the past two years have caused production to fall off. About 80 per cent of the cut is normally made in Idaho, and 15 per cent in Washington. Ninety per cent of the total is cut by large, well-equipped mills, nearly all of which saw associated species as well as pine. About 30 per cent of their total cut is white pine. The capacity of existing mills would allow nearly double the present cut.

The logging season usually lasts from six to eight months, being limited by the deep snows which fall in much of the region. Logs are usually cut 16 feet or less in length. The majority of operators use animal logging, but a few large concerns log by steam. Logs are either driven to the mills or carried by rail. While no attempt is usually made to saw straight-grained material, most of the larger operators have become familiar with the requirements for airplane material during the war, and can saw it if it is in demand.

Most of the airplane material will come from the clear grades of lumber. The grading rules allow a few small knots in these grades, and probably these defects, together with crooked


LOCATION OF IMPORTANT PRODUCERS OF WESTERN WHITE PINE LUMBER IN 1917
MAP No. 7
· Mills cutting 500 M ft. BM or more
● Mills cutting 10000 M ft. BM or more

grain and low density, would cause the rejection of a small proportion of the upper-grade material. It is estimated that an average of from 2 to 3 per cent of the cut of western white pine would be suitable for aircraft construction.

MARKETS AND USES FOR THE LUMBER.

Western white pine is used for about the same purposes as eastern white pine. The upper-grade lumber is largely employed for sash, doors, interior finish, and similar purposes, and is marketed to a large extent in the agricultural States to the east. A little of it goes as far as the Atlantic coast. Lower-grade lumber is used in building and for boxes and crates, for which there is a good demand in the white-pine section and adjacent regions.

SUGAR PINE.

(*Pinus lambertiana.*)

DISTRIBUTION.

Sugar pine occurs on the Coast ranges of southern Oregon and northern California and along the southern Cascades, the west slopes of the Sierras, and in lower California. It is most abundant and of best development in the Sierras.

USE IN AIRCRAFT.

Sugar pine is low in shock resisting ability and in the quality of stiffness, and it varies widely in its strength properties. It is not, therefore, well adapted for wing beams or other parts of aircraft where great strength is a requisite. Being soft, light, and easy to work, it may be used in less critical parts, particularly for plywood cores. Since, however, it is likely that spruce and other species cut for wing beams will yield a large supply of suitable small-sized material, sugar pine may never become very important for airplane uses.

SUPPLY OF TIMBER.

Sugar pine never occurs in extensive pure stands, but is scattered through stands of western yellow pine, Jeffrey pine, white fir, incense cedar, and Douglas fir, where it usually comprises from 10 to 30 per cent of the stand. It grows at medium elevations in rolling or rough country and, for the most part, where it can be logged without great difficulty. Still much of the sugar pine country is as yet undeveloped, and probably less than one-third of the total stand is available to existing mills. Sugar pine reaches large sizes; diameters of 6 feet or more are common, with heights up to 200 feet or even more.

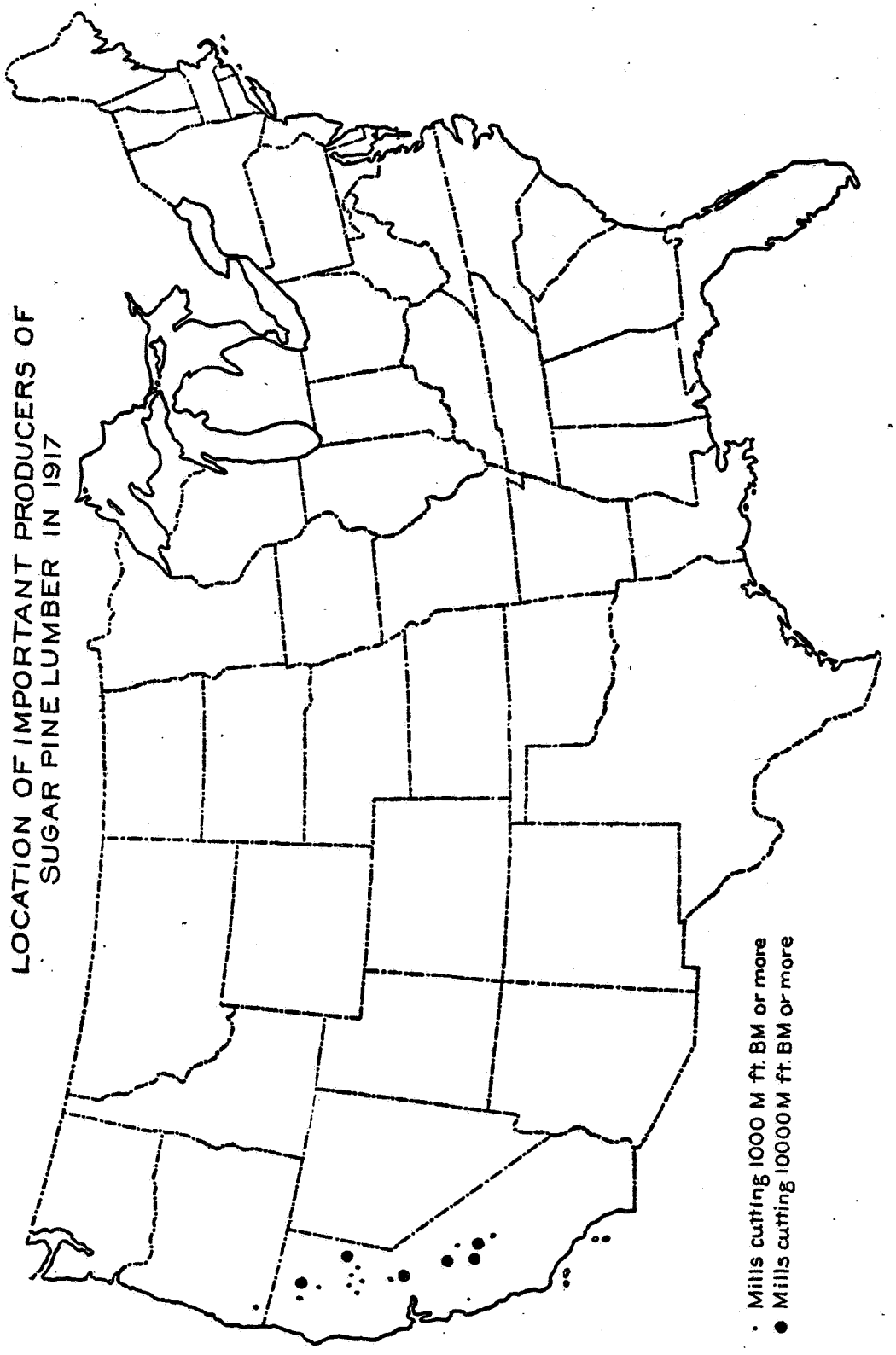
The stand of this species has been estimated at 45 billion feet, of which 33 billion feet is in California and 12 billion feet in Oregon. The figure for Oregon is probably very much too high. Fourteen billion feet in California and 2 billion feet in Oregon is on National Forests. Most of the remainder is privately owned, principally by large lumber companies, the Southern Pacific Railroad, and large landowners.

PRODUCTION OF LUMBER.

From 1913 to 1917 the average annual cut of sugar pine lumber was 140 million feet, which represents nearly 30 per cent increase over the cut between 1907 and 1912. All but an insignificant amount of this lumber was cut in California, and 90 per cent of it by large mills. In 1917, 6 mills reported the production of more than 10 million feet of sugar pine each, and 11 other mills reported cuts of between 1 and 10 million feet. Sugar pine makes up one-fourth of the total cut of the mills which saw it. Most of these mills cut chiefly western yellow pine, with some white fir, Douglas fir, and incense cedar. The mill capacity of the region is more than twice the present cut. The large available supply of timber indicates that the cut may be expected to increase for some time.

Logs are cut between May and November, deep snow in the mountains making winter logging impracticable. Sugar pine is cut as it comes with its associated species. Steam logging is generally practiced by the larger companies, but animals are also used to a considerable extent. All large operators use logging railroads. Logs are generally cut from 10 to 20 feet long.

It is estimated that 9 per cent of the total cut of sugar pine falls in the two upper grades, No. 1 and No. 2 clear, and 4 per cent in No. 3 clear. Material suitable for airplane use will come chiefly from these grades, together with a small amount of short material from No. 1 shop. Probably from 9 to 10 per cent of the total cut will be suitable for aircraft.


LOCATION OF IMPORTANT PRODUCERS OF SUGAR PINE LUMBER IN 1917
MAP No. 8
· Mills cutting 1000 M ft. BM or more
● Mills cutting 10000 M ft. BM or more

MARKETS AND USES FOR LUMBER.

Approximately half the cut of sugar pine lumber is normally used as it comes from the sawmill for construction and similar purposes. The other half is further manufactured into a variety of forms, chief among which are planing-mill products (sash, doors, blinds, finish), which use 26 per cent of the total cut, and boxes and crates, which use 20 per cent of the total. Small quantities, chiefly high-grade material, go into musical instruments, furniture, patterns, woodenware, fixtures, and boats.

A considerable part of the high-grade material finds its way to eastern markets. The lower grades of lumber and the box material are used principally in California, where the demand for such material is great.

WESTERN HEMLOCK.

(*Tsuga heterophylla.*)

This species is also known as Prince Albert's fir and Alaska pine.

DISTRIBUTION.

Western hemlock occurs from northwestern Montana and northern Idaho to Alaska, and south along the Cascades and Coast ranges to central California. It is of commercial importance in the Pacific coast region from southern Oregon to Alaska.

USE IN AIRCRAFT.

Heavier than spruce, but lighter than Douglas fir, western hemlock is low in shock resistance. It might be used as a substitute for spruce, but it is probable that it will be so used only to a limited extent so long as supplies of better material are available. It makes a satisfactory core for plywood, and may sometimes be of considerable importance for this purpose, since the supply is large and the wood comparatively cheap.

SUPPLY OF TIMBER.

Along the Pacific coast, western hemlock is usually the predominant species in mixed stands with spruce, western red cedar, Douglas fir, and grand fir. It is sometimes found in pure stands along the coast of Washington and Oregon, while in Alaska extensive pure stands of hemlock or mixed stands of hemlock and Sitka spruce are common. Along the Cascades it forms a much smaller proportion of the stand. The timber is nearly all in dense virgin stands, on both lowlands and higher slopes. Trees reach large size, with diameters at maturity of from 6 to 10 feet and heights up to 200 feet.

The stand in Washington, Oregon, and Alaska is estimated at about 132 billion board feet, of which approximately 57 billion feet is privately owned, chiefly by large timber companies, and 75 billion feet by the public, mostly on National Forests. Thirty-three billion feet is in Oregon, 54 billion feet in Washington, and 45 billion feet in Alaska.

PRODUCTION OF LUMBER.

The average annual cut of western hemlock lumber averaged 325 million feet for the years 1913 to 1917. Nearly 85 per cent of it was produced in Washington and most of the rest in Oregon. In 1917, 10 mills, all in Washington, reported cuts of more than 10 million feet of hemlock. Forty-four mills in Washington, 19 in Oregon, 1 in California, and 1 in Idaho reported cuts of between 1 and 10 million feet. Hemlock is considered an inferior species by most operators, and is cut along with other species only incidentally. In selecting logging chances, areas which run heavily to hemlock are usually passed by for those with larger proportions of the more valuable species. Hemlock makes up about 11 per cent of the cut of the mills reporting it. If they operated to capacity (one shift) and cut hemlock in the same proportion as at present, existing mills could increase their production more than 50 per cent. Production will probably tend to increase for many years as the lumber industry of the Northwest develops.

Logging is carried on for about 10 months in the year. Steam logging is the rule, with railroad or, in some cases, water transportation. Logs are cut from 32 to 40 feet long. Operators make no effort to saw for straightness of grain, but attempt to get a maximum amount of clear material.

The best available estimates indicate that not more than 3 per cent of the cut is in the two upper grades of hemlock, which include most of the material suitable for airplanes. It is estimated that not more than one-third of the material in these grades, or 1 per cent of the total lumber cut, could be used for this purpose.

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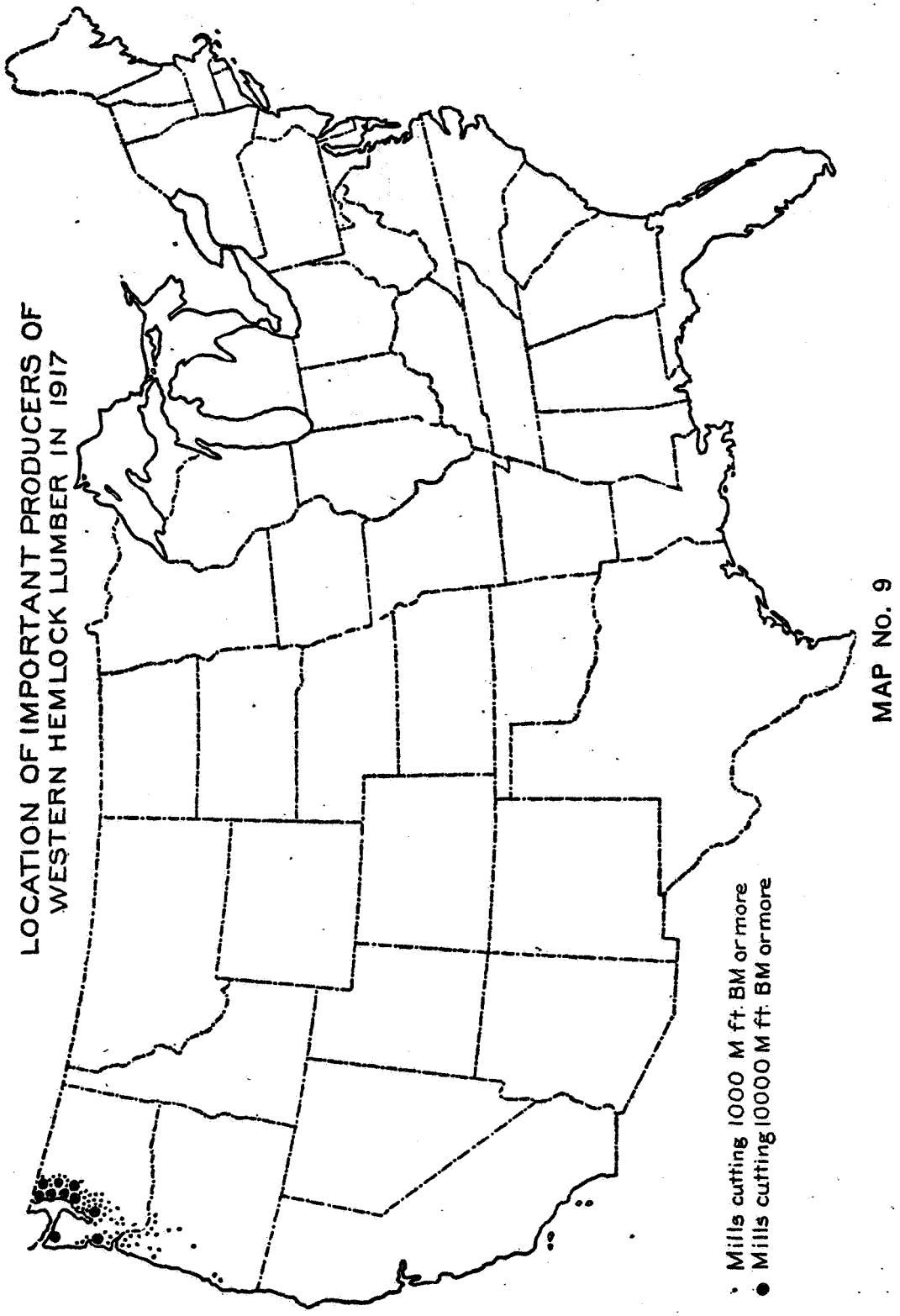

LOCATION OF IMPORTANT PRODUCERS OF WESTERN HEMLOCK LUMBER IN 1917
• Mills cutting 1000 M ft. BM or more
● Mills cutting 10000 M ft. BM or more
MAP No. 9

MARKETS AND USES FOR THE LUMBER.

The bulk of hemlock lumber (including eastern and western species) is used in the rough for construction work, and only about 30 per cent is further manufactured. Most of this goes into planing-mill products, which consume 17 per cent of the cut, and into boxes and crates, which use 8 per cent. Most of the upper-grade western hemlock is used for finish, flooring, and siding.

Western hemlock is marketed along with Douglas fir. Probably the greater part of it, being comparatively low-grade material, is used on the Pacific coast and in contiguous territory.

REDWOOD.

(*Sequoia sempervirens.*)

Bigtree (*Sequoia gigantea*) is included with the redwood in the discussion in this chapter.

DISTRIBUTION.

The redwood occurs in the coast belt of northern California from just below San Francisco Bay to the Coos Bay district of southern Oregon. The bulk of it is in Del Norte, Humboldt, and Mendocino Counties, Calif. The bigtree, which is also sold as redwood, occurs on the west slope of the central Sierras over very limited areas.

USE IN AIRCRAFT.

Redwood is variable in its properties and is apt to be brash; hence it is probably not suitable as a substitute for spruce in aircraft. It is, however, an excellent wood for plywood cores on account of its lightness and the ease with which it can be worked.

SUPPLY OF TIMBER.

Redwood forms pure forests in northern California; farther south it occurs as groves scattered among other species. The trees reach enormous size, with very heavy stands. Redwood is seldom found above 3,000 feet elevation. Bigtree reaches even larger sizes than does redwood. It usually occurs in groves mixed with such other species as western yellow pine, sugar pine, white fir, and incense cedar, and is found at elevations between 5,000 and 8,400 feet.

The total stand of redwood is estimated at about 73 billion board feet, practically all of which is in the hands of a few large private owners.

PRODUCTION OF LUMBER.

The annual cut of redwood lumber has not fluctuated widely for the past 10 or 15 years from the average of approximately 500 million board feet. Almost the entire cut is produced by 34 mills, which handle redwood almost exclusively. The capacity of these mills is rated at about 850 million feet a year. In 1917, 18 mills reported cuts of from 5 to 25 million feet, 4 mills from 25 to 75 million feet, and 1 mill in excess of 75 million feet. Two of these mills were in the coast region below San Francisco Bay, one was in the Sierra bigtree region, and the rest were on the northwest coast.

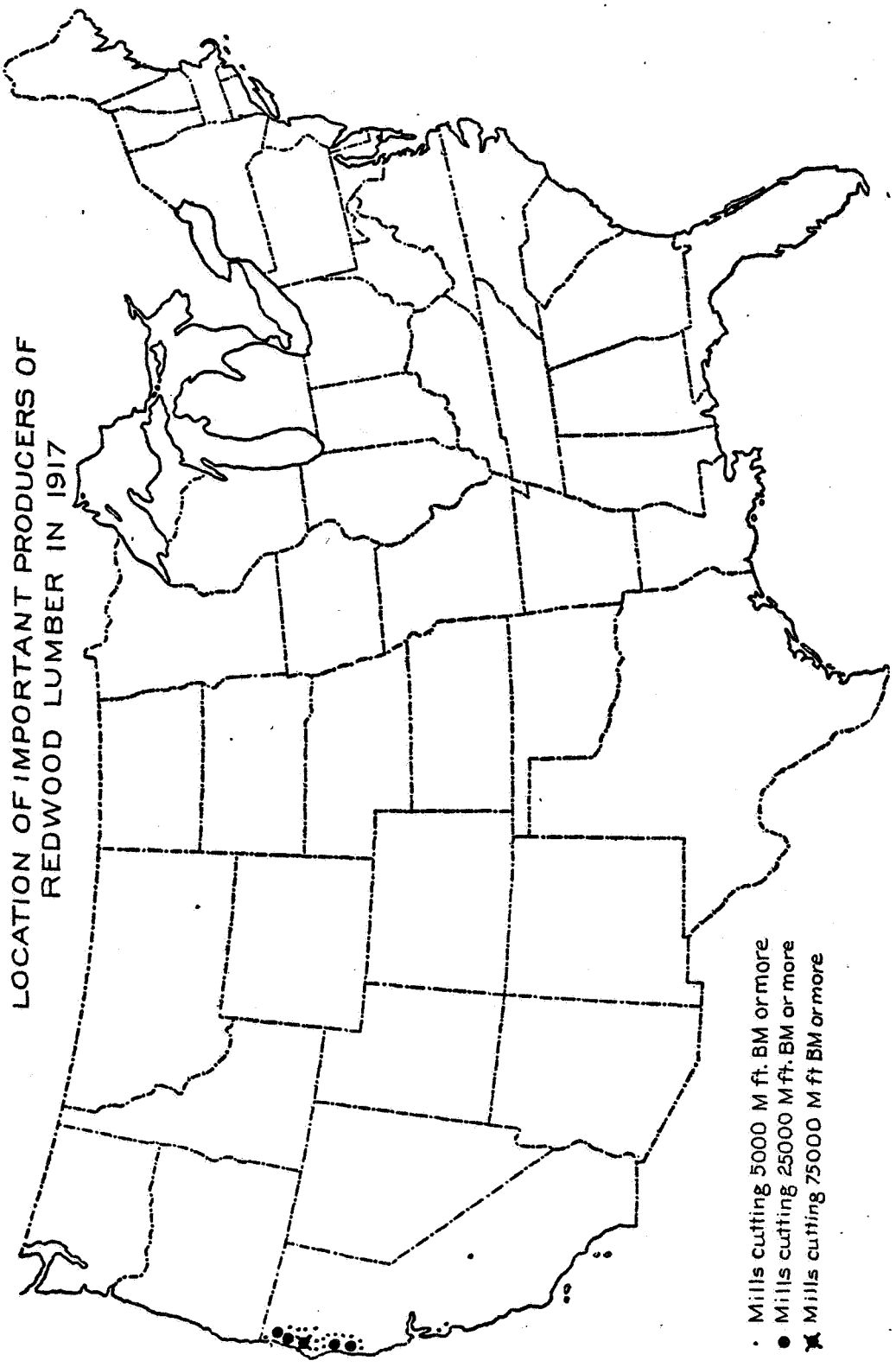
Logging operations are carried on throughout the year in the redwood belt. All operators use steam equipment and logging railroads. Most of the upper-grade lumber is now cut in 16-foot lengths. While no particular effort is made to saw straight-grained material, redwood is naturally straight grained and the proportion of such material produced is large.

About 50 per cent of the cut is in the Clear and Sap Clear grades, and it is estimated that, after allowing for grain, pitch pockets, shake, and other defects, at least half of this, or 25 per cent of the cut, will be suitable for aircraft construction.

MARKETS AND USES FOR THE LUMBER.

Three-fourths of the redwood lumber produced by sawmills is used, without further manufacture, for general construction and for railroad ties. Planing-mill products take 19 per cent of the cut, wood pipe about 2 per cent and tanks and silos almost as much. A great number of industries use smaller amounts.

A large proportion of the lumber and ties, as well as of the manufactured products, is used in California. Redwood is sold, however, in all parts of the United States and is shipped to a number of foreign countries, especially to those on the Pacific.


LOCATION OF IMPORTANT PRODUCERS OF REDWOOD LUMBER IN 1917
· Mills cutting 5000 M ft. BM or more
● Mills cutting 25000 M ft. BM or more
✖ Mills cutting 75000 M ft BM or more

MAP No. 10

BALD CYPRESS.

(*Taxodium distichum.*)

This species is also known as cypress, swamp cypress, southern cypress, black cypress, red cypress, and white cypress.

DISTRIBUTION.

Cypress occurs in the Atlantic and Gulf coastal regions from southern Delaware to Texas, and along the bottom lands of the Mississippi and its tributaries to southern Illinois and Indiana. It is best developed and most abundant in southern Louisiana (Atchafalaya region) and in Florida.

USE IN AIRCRAFT.

Cypress is slightly heavier than spruce. Carefully selected pieces are somewhat superior in strength to spruce when used in the same sizes. It is, however, greatly variable in its strength properties, and selection of suitable pieces is difficult on that account. Furthermore, satisfactory methods of drying and gluing have not yet been developed. Until these difficulties are overcome it will probably not be a popular wood for aircraft use.

SUPPLY OF TIMBER.

Cypress grows in practically pure stands or in mixture with tupelo over large areas of swampy land where most other species can not live. It is also found in mixture with a great variety of hardwoods common to the region. Stands are frequently very heavy, and mature trees are of very large size. Diameters of from 6 to 8 feet or even more are not uncommon.

The total remaining stand has been variously estimated at from 25 to 40 billion board feet, the lower figure probably being more nearly correct. Possibly half of the stand is available to existing plants. Most of it is owned in large units by land and lumber companies.

PRODUCTION OF LUMBER.

An average of slightly over a billion feet of cypress lumber was cut each year from 1913 to 1917, which is more than 100 million feet in excess of the average cut during the six preceding years. The cut is now about stationary, but will decline in a few years as the virgin supply becomes more nearly exhausted. More than half of the total cut now comes from the Atchafalaya Basin of southern Louisiana, and about 20 per cent is cut in Florida. Eighty per cent of the total is cut by some 205 large mills.

Trees are usually girdled for some months before they are felled, in order to make the logs lighter. Logs are commonly cut 16 feet or shorter, and are gotten together by means of steam skidders mounted on "pull boats." They are then towed to the mills. Some operators use railroad transportation where the surface conditions allow it. The logs are usually sawed without regard to straightness of grain. To produce airplane stock they should be sawed parallel to the bark, since the taper is excessive. Since cypress lumber is very hard to kiln-dry on account of its tendency to caseharden and to check, it is usually air-dried for nearly a year before being shipped.

Because of the difficulties in the way of the use of this species, particularly with regard to its great variability in density, it is not easy to estimate how much is suitable for aircraft. Such material will come largely from the grades known as tank (1 per cent of the average cut), A (8 per cent), B (7 per cent), and factory selects (5 per cent). A rough estimate places the possible airplane stock at about 12 per cent of the total cut.

MARKETS AND USES FOR THE LUMBER.

One-third of the cypress lumber cut is used as it comes from the mill for construction and similar purposes. One-half of the cut is used for planing-mill products—sash, doors, finish, molding, and similar uses. Four per cent is used for boxes and crates, 3½ per cent for tanks and silos, 2 per cent for caskets and coffins, 1½ per cent each for laundry appliances and machine construction. Smaller quantities are applied to many other uses.

Cypress lumber is very widely sold in the United States, and considerable quantities go to foreign countries.

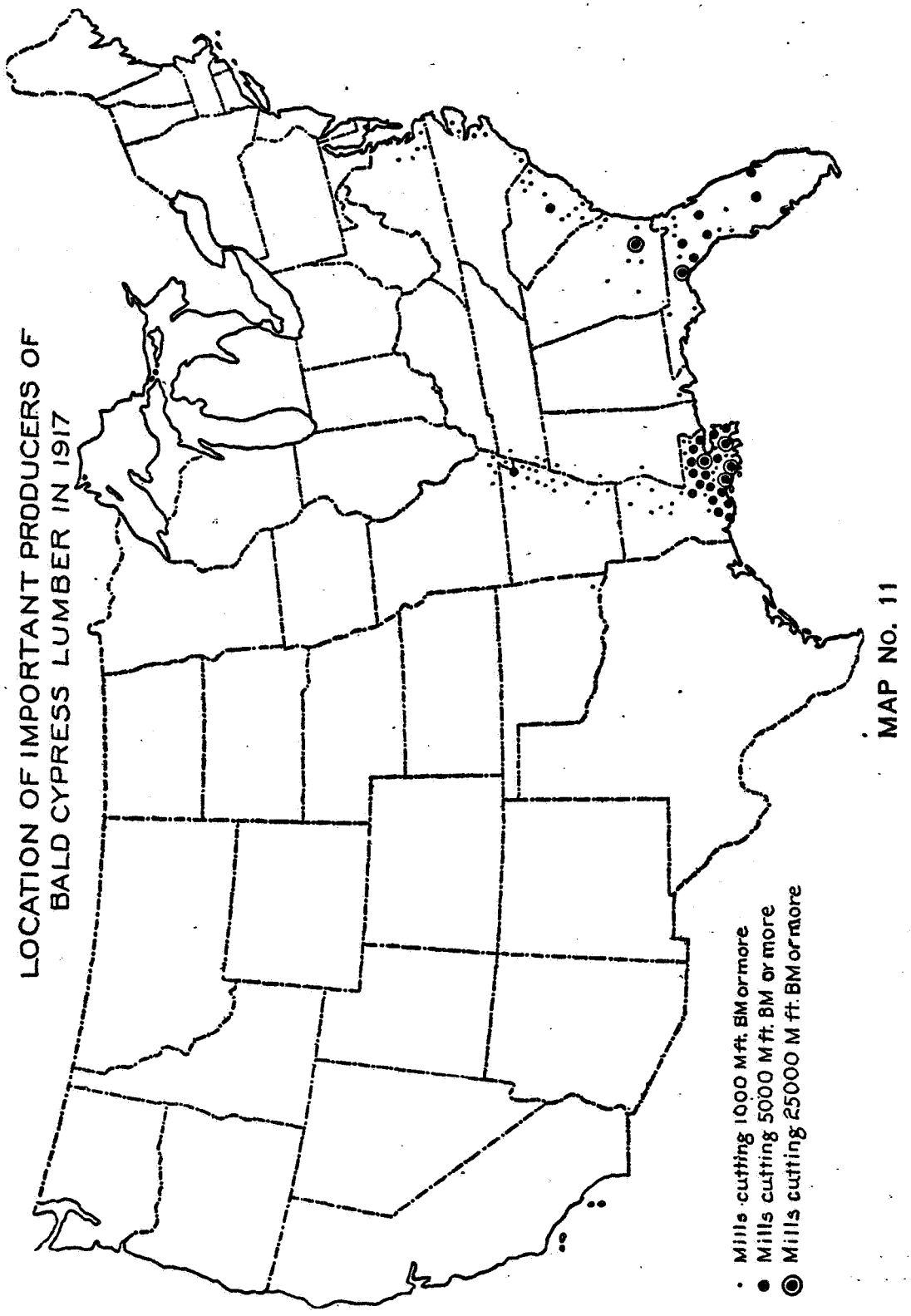
ASH.

WHITE ASH (*Fraxinus Americana*). BILTMORE ASH (*Fraxinus biltmoreana*). GREEN ASH (*Fraxinus lanceolata*). PUMPKIN ASH (*Fraxinus profunda*). OREGON ASH (*Fraxinus oregona*). BLACK ASH (*Fraxinus nigra*). BLUE ASH (*Fraxinus quadrangulata*).

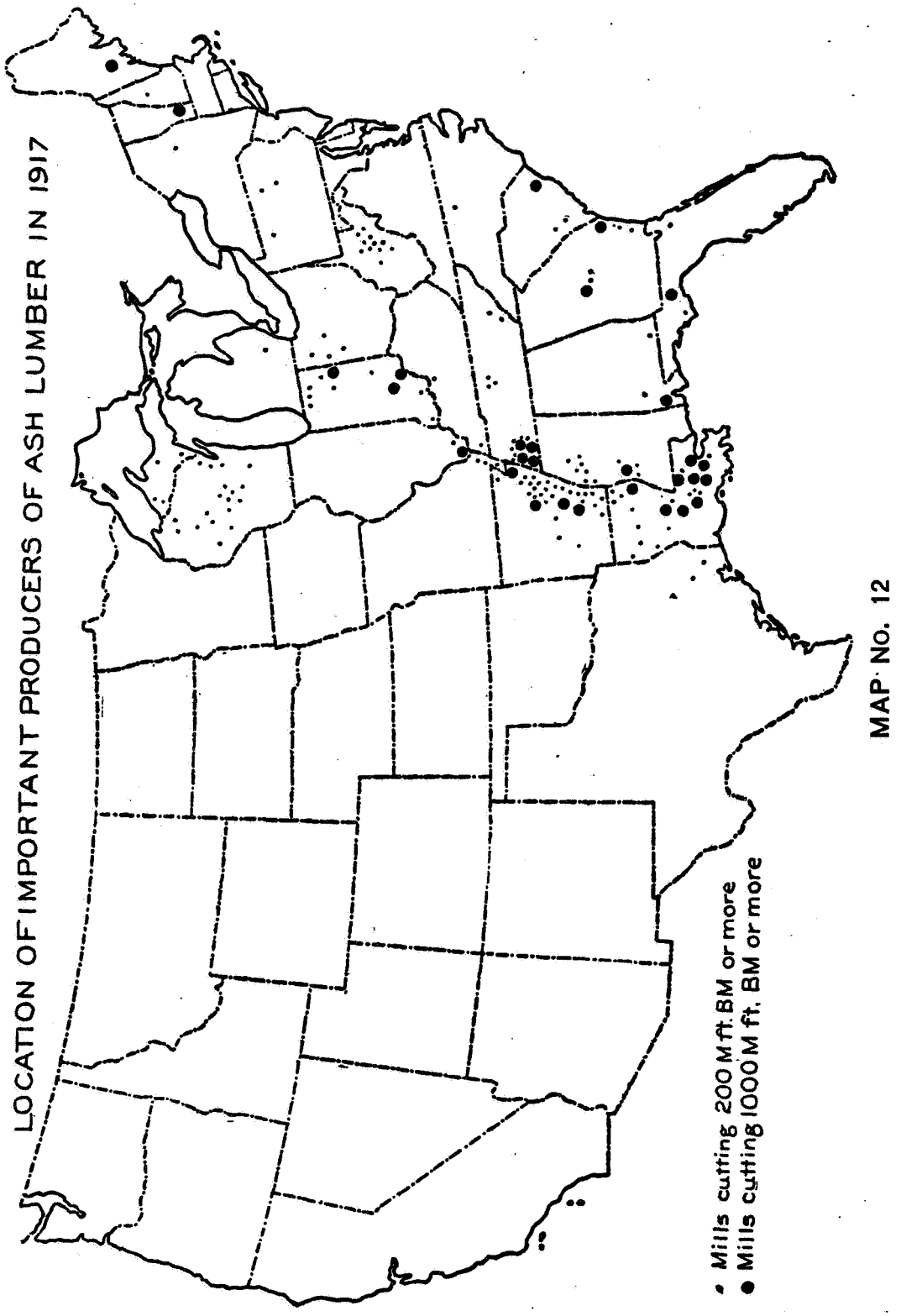
There are about ten other species of ash, none of which, however, are of commercial importance.

DISTRIBUTION.

Ash occurs all over the eastern United States and along the streams in the Plains region almost to the foothills of the Rocky Mountains. Several species of no commercial importance occur in the Southwest. The Oregon ash, which is of some importance within its range, occurs in the Pacific coast region from Puget Sound to central California and along the foothills of the mountains as far as southern California.


LOCATION OF IMPORTANT PRODUCERS OF BALD CYPRESS LUMBER IN 1917
· Mills cutting 1000 M ft. BM or more
● Mills cutting 5000 M ft. BM or more
◉ Mills cutting 25000 M ft. BM or more

MAP No. 11


LOCATION OF IMPORTANT PRODUCERS OF ASH LUMBER IN 1917
MAP No. 12
• Mills cutting 200 M ft. BM or more
● Mills cutting 1000 M ft. BM or more

White ash is common in all States east of the Mississippi, except in the Coastal Plain region, but is not very important in the lower Mississippi valley. Biltmore ash is chiefly in Tennessee, Kentucky, Ohio, and Indiana. Green ash is of greatest commercial importance in the bottomlands of the Mississippi and its tributaries and in the Coastal Plain region. Pumpkin ash is of importance only in southeastern Missouri and eastern North Carolina. Oregon ash is of some importance in Washington and Oregon. Black ash is chiefly found in the Lake States and in northern New England and New York. Blue ash is of some importance in Kentucky, Tennessee, Indiana, Ohio, and southern Missouri.

USE IN AIRCRAFT.

The ashes known commercially as "white ash" include both white ash and green ash, as well as the Biltmore and blue ashes. All of these are very desirable woods for use in aircraft. White ash has great strength and stiffness, bends very well, and is usually fairly straight grained. It is used very extensively for longerons, bent work on wings and fuselage, landing skids, and other parts of the framework of aircraft, and has been used to some extent for propellers. Second-growth ash is more likely to have the requisite density and hence is frequently considered more desirable than old-growth ash for those uses in which great toughness is required. Oregon ash is probably as good as white ash. Black ash is not so stiff as the others, but is very tough and is excellent for bending. It should make good plywood. Pumpkin ash is lighter and weaker than the other ashes, and therefore, is not desirable for airplane construction. Northern-grown white ash has been considered more satisfactory than that from the South, probably on account of the fact that a large part of the ash now cut in the North is from second-growth stands, and because the northern ash has on the average a higher density than that from the South, which is largely green ash. In the South brash material of the better species of ash is usually sold under the name of pumpkin ash.

SUPPLY OF TIMBER.

Ash occurs in mixed hardwood stands and seldom forms more than a small proportion of the mixture. White ash in the North ordinarily makes up from 5 to 10 per cent of old stands, and sometimes from 20 to 50 per cent of second-growth stands over limited areas. Green ash is a more important component of most of the stands in which it occurs, and is frequently the predominant species in certain parts. Black ash makes up from 1 to 10 per cent of the stands where it grows, and over limited areas is occasionally the predominant tree.

Except in northern New England and New York and in northern Michigan and Wisconsin, most of the northern and eastern ash is from second-growth stands, and a large part of it is from woodlots. The Southern ash, as well as some of that in the Lake States, still comes to a large extent from extensive tracts in virgin forests. The old-growth supply is rapidly dwindling, and a larger and larger proportion of the cut is coming from second growth.

There are no available estimates of the stand of ash by species. The total of all species is estimated at about 10½ billion board feet, of which about 1½ billion feet is in New England and New York, 1½ billion feet in the Lake States, 1½ billion feet in the central woodlot region, 1½ billion feet in the southern Appalachians, and 4½ billion feet in the lower Mississippi valley and Gulf region.

In about the order named, the States with the largest stands are: Arkansas, Louisiana, Missouri, Ohio, Texas, Mississippi, Michigan, Tennessee, Georgia, Minnesota, Wisconsin, Maine, and New York. These States have about three-fourths of all the ash in the United States.

PRODUCTION OF LUMBER.

The average cut of ash lumber during the five years 1913 to 1917 was just under 200 million feet a year, or about 50 million feet less than the average annual cut during the preceding six years. The lumber cut is steadily declining and may be expected to do so until it reaches a figure approximately equal to the annual increase of second-growth stands.

Besides the ash cut in the form of lumber, much of the handle and vehicle stock is cut directly from logs or bolts, from 25 to 35 million feet is used for slack cooperage, and 2 or 3 million feet is made into veneer. In normal times from 5 to 7 million feet of ash logs is cut for export.

Arkansas and Louisiana are now the leading States in the production of ash, and together they produce one-fourth of all the ash lumber cut in the United States. Following them, come Wisconsin, Tennessee, Indiana, Mississippi, New York, and Michigan. These States together produce about 60 per cent of the total. Twenty-nine mills reported cuts in 1917 of more than one million feet of ash. Two of these were in northern New England, 3 in Indiana, 5 in the southern coastal region, and the rest in the lower Mississippi valley. Ash lumber is cut in smaller amounts by a very large number of both large and small mills.

Logging in most of the ash regions is carried on throughout the year, except that in the river bottoms it is usually interrupted by high-water periods. Steam logging is sometimes employed, but animal logging is used by most operators. Logs are carried to the mills by rafts, railroads, teams, or motor trucks, according to the region in which the operations are conducted. Logs are usually cut in lengths of 16 feet or less. Many operators use considerable care to saw straight-grained lumber, particularly from the white ashes, since so many of the uses to which high-grade ash is put require straightness of grain.

The strongest material is usually sawed from within 7 inches of the center of the trees; consequently, trees of comparatively small diameters may produce as much airplane material as trees from virgin stands. The proportion of high-grade material produced varies, of course, with the size of the trees as well as with the locality where they grow. From second-growth white ash stands, trees under 10 inches in diameter yield no firsts and seconds, and about 50 per cent No. 1 common; trees 20 inches in diameter yield over 40 per cent firsts and seconds, and about 35 per cent No. 1 common. Assuming the average diameters to be from 14 to 16 inches, an average proportion is about 25 per cent firsts and seconds, and 42 per cent No. 1 common.

MARKETS AND USES FOR THE LUMBER.

Practically all of the ash lumber cut is further manufactured before it reaches the consumer. Approximately 22 per cent is used for handles, especially those for spades, shovels, hoes, rakes, and forks, for which long, stiff, tough, straight-grained pieces are required. More ash than any other wood except hickory is used for handles. Twenty per cent of the cut is used for butter tubs. This material is nearly all green and black ash, and comprises short, clear lengths cut from low-grade logs. Fifteen per cent is used in vehicle manufacture, for such parts as poles, tongues, axles, and felloes, which require tough white or green ash of high quality, and for bodies, which are made of larger pieces of old-growth ash. Planing-mill products take 7 per cent of the cut, much of it black ash. Refrigerators and kitchen cabinets (mostly black ash), furniture (mostly black ash), car construction (all species) each take about 6 per cent of the cut. Agricultural implements and oars (both of which require high-grade white and green ash) each take about 3 per cent. Athletic goods, musical instruments, fixtures, hames, and many other products that call for a good grade of material take smaller amounts.

Ash is either manufactured into the finished product near where it is cut or is shipped to the centers of the wood-manufacturing industry in the Northern and Eastern States. Several million feet of logs is normally exported to Europe each year and several million feet of lumber goes to Europe and to South America.

BASSWOOD.

(*Tilia americana.*)

This species is also called linden, linn, and whitewood. Downy basswood (*T. pubescens*) and white basswood (*T. heterophylla*) should probably also be grouped with the common basswood. Data are not available, however, with respect to the strength of these species.

DISTRIBUTION.

Basswood occurs from northern New Brunswick to Lake Winnipeg, south to Virginia, northern Georgia and Alabama, eastern Texas, and as far west as eastern Dakota, Kansas, and Oklahoma. It reaches its largest size in the lower Ohio River bottom lands, but is more abundant northward.

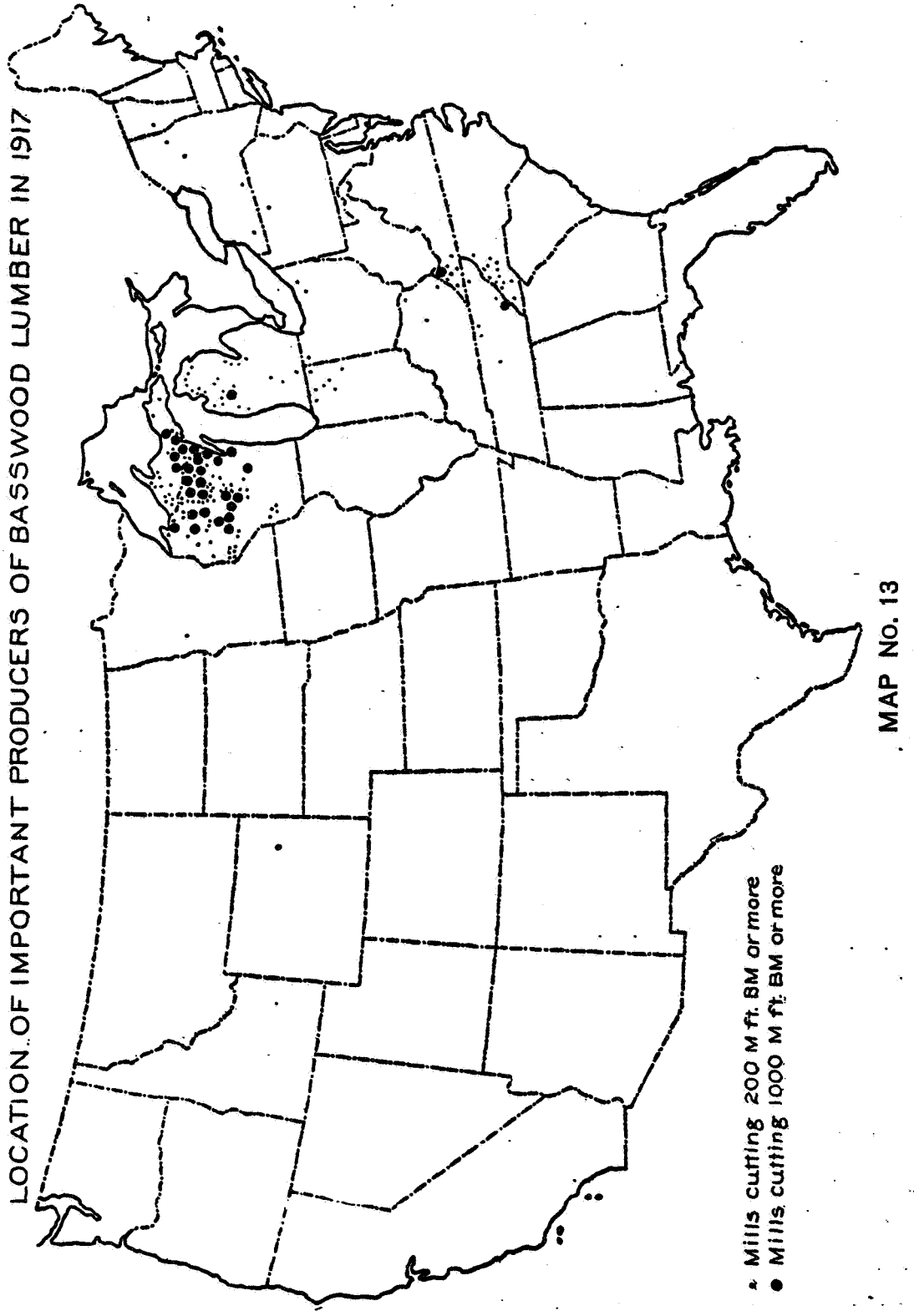
USE IN AIRCRAFT.

Basswood is light in weight but low in strength; consequently it is not a good substitute for spruce. It is, however, one of the best woods in ability to take nails without splitting, and is excellent for webs of wing ribs and for plywood cores generally. It is also used for thin flooring plank.

SUPPLY OF TIMBER.

Through most of its range basswood is found in mixture with other hardwoods. In the North it frequently is the predominating species in the stand, and sometimes forms pure stands over limited areas. Mature trees frequently reach diameters of from 3 to 4 feet and heights of more than 100 feet. While much of the basswood is in situations in which logging can be done with little difficulty, a considerable part of it is in localities as yet undeveloped and is not available to existing mills.

The total stand is estimated at approximately 9 billion board feet, of which 80 per cent is in Wisconsin, Michigan, Minnesota, Iowa, New York, Kentucky, West Virginia, and Vermont, in the order named. There is about 1½ billion feet in New England and New York, 5 billion


LOCATION OF IMPORTANT PRODUCERS OF BASSWOOD LUMBER IN 1917
MAP No. 13
▲ Mills cutting 200 M ft. BM or more
● Mills cutting 1000 M ft. BM or more

feet in the Lakes States, 1½ billion feet in the southern Appalachians, and 1 billion feet in the central wood-lot region.

Much of the virgin stand, which is in northern New England, the Lake States, and the southern Appalachians, is owned by large land and lumber companies. Outside of these three regions, most of the basswood is in small holdings.

PRODUCTION OF LUMBER.

For the five-year period 1913 to 1917, the average annual cut of basswood lumber was approximately 250 million board feet, which was nearly 100 million feet less than the average cut during the preceding six years. The general tendency indicates a steady decline as the accessible virgin supplies become more nearly exhausted. One-third of the total is cut in northern Wisconsin, one-fifth in Michigan, and one-eighth in West Virginia. These States, with New York, cut about three-fourths of the total.

From 95 to 99 per cent of the basswood cut in Michigan and Wisconsin and the larger part of that cut in West Virginia is produced by large mills. In 1917, 32 mills reported cuts of more than a million feet of basswood, and about 180 reported cuts of between 200 thousand and a million feet. Basswood was cut along with a variety of other woods by all of these mills and formed only a minor part of the total output of most of them.

Logging operations proceed the year round in most of the basswood region. Animals are quite generally used, although a few companies log with steam. The large operations in the Lake States and in the South are railroad operations. Logs are commonly cut 16 feet or less in length. Mills cut for grade, but not particularly for straight grain. Some 10 million feet of basswood veneer is cut each year.

It is estimated that from 16 to 20 per cent of the basswood cut will grade firsts and seconds, and that from 22 to 25 per cent will grade No. 1 common. The proportions will probably run a little higher in the South, where the trees are somewhat larger. Material suitable for aircraft construction will come from these grades, principally from the first.

MARKETS AND USES FOR THE LUMBER.

Practically all of the basswood lumber cut is further manufactured before it reaches the consumer. Twenty-three per cent of the total goes into the box industry; 16 per cent into finish and other planing mill products; 16 per cent into woodenware; 9 per cent into furniture; 6 per cent (more than of any other one species) into trunks and valises; 5½ per cent into picture frames and molding; 3 per cent into musical instruments; 2½ per cent into toys. A wide variety of other industries use lesser amounts.

Basswood lumber is marketed chiefly in the region of wood-manufacturing industries, that is, the North Atlantic and North Central States.

BEECH.

(*Fagus atropunicea.*)

DISTRIBUTION.

Beech occurs from New Brunswick to northern Wisconsin and south to eastern Texas and western Florida. It reaches its best development in the Northern States, the lower Ohio Valley and the Appalachians.

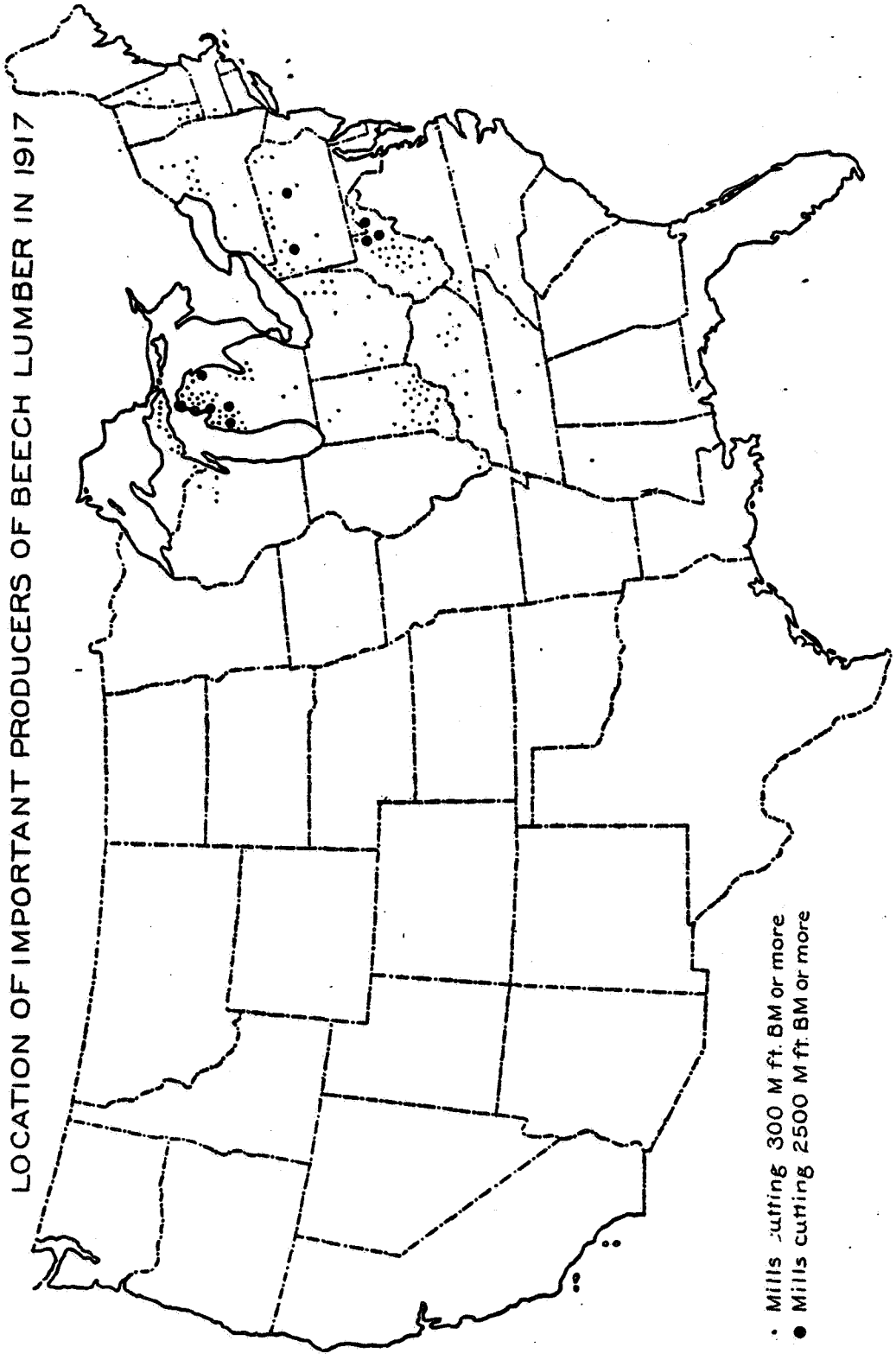
USE IN AIRCRAFT.

Having strength properties very similar to those of maple and birch, it makes a fairly satisfactory propeller wood where requirements are not too exacting, and was used for this purpose to some extent in Europe. It is also a satisfactory material for plywood. Because of the comparatively large and accessible supplies of the timber fairly close to centers of consumption, and because of the cheapness of the material, beech may be of considerable importance in the future of airplane manufacturing.

SUPPLY OF TIMBER.

Beech sometimes forms nearly pure stands over limited areas, but is usually found in mixture with other species, such as birch, sugar maple, basswood, and hemlock. In such mixtures it is frequently the predominant species. Mature trees 3 feet or more in diameter are common. Most of the beech is in fairly accessible regions, in situations which offer no serious difficulty in logging.

While accurate data as to the stand of beech timber are lacking, rough estimates indicate that there is from 20 to 25 billion board feet in the United States. Seven-eighths of it is in the


LOCATION OF IMPORTANT PRODUCERS OF BEECH LUMBER IN 1917
· Mills cutting 300 M ft. BM or more
● Mills cutting 2500 M ft. BM or more
MAP No. 14

following States, which are named in the order of their importance as beech States: Michigan, New York, Maine, Indiana, Kentucky, Ohio, New Hampshire, Vermont, Pennsylvania, and West Virginia. It is estimated that there is about 8 billion feet in New England and New York, 4 billion feet in Michigan and Wisconsin, 5 billion feet in the southern Appalachians, and 4 billion feet in the central woodlot region.

Much of the virgin timber in the Lake States, northern New England and New York, and the Appalachians is held by large lumber companies or land companies. A large amount of beech, however, is found on small holdings, particularly in the Central States.

PRODUCTION OF LUMBER.

The average annual cut of beech lumber in the United States from 1913 to 1917, was 350 million feet. For the six years previous it was 440 million feet per year. The production of beech lumber is, therefore, slowly declining and may be expected to do so until it reaches the point where it does not exceed the increase in second-growth stands. Michigan produces 20 per cent of the total, followed by Indiana, West Virginia, Pennsylvania, New York, Ohio, and Kentucky. The first five States named produce nearly three-fouths of the total.

Beech is cut, along with associated hardwoods or hardwoods and conifers, by a large number of both large and small mills. Probably the larger proportion of the high-grade material is produced by fairly large mills, each of which cuts several hundred thousand feet of beech. There are only about a dozen mills that cut more than 2½ million feet of beech apiece. Horse logging is the rule in the beech territory, although a few large operators use steam. Both animal and railroad transportation are used, and, where roads are good, motor trucks are coming into use to carry logs to the mill. Logging operations are carried on during most of the year.

In the Lake States, approximately 12 per cent of the cut will grade firsts and seconds, and 23 per cent No. 1 common. Possibly the Ohio valley and Appalachian timber may run a little better. It is estimated that from 5 to 10 per cent of firsts and seconds can be cut into quarter-sawed stock suitable for propellers.

MARKETS AND USES FOR THE LUMBER.

About 65 per cent of the beech lumber produced is further manufactured. Of this amount, 13.5 per cent is made into planing mill products; 11.2 per cent into furniture and chairs; 3.9 per cent into handles; 3.3 per cent into woodenware; 2 per cent into laundry appliances, and 1.5 per cent into brushes. Lesser quantities are utilized for vehicles, agricultural implements, musical instruments, spools and bobbins, tops, and many other products. The box and crate industry uses 18.3 per cent.

On the whole, beech lumber is generally sold quite near the place where it is produced, since much of the beech region is also the section of woodworking industries.

BIRCH.

SWEET BIRCH (*Betula lenta*).

This species is also known as black birch, cherry birch, and mahogany birch.

YELLOW BIRCH (*Betula lutea*).

This species is also known as silver birch, swamp birch, and gray birch.

DISTRIBUTION.

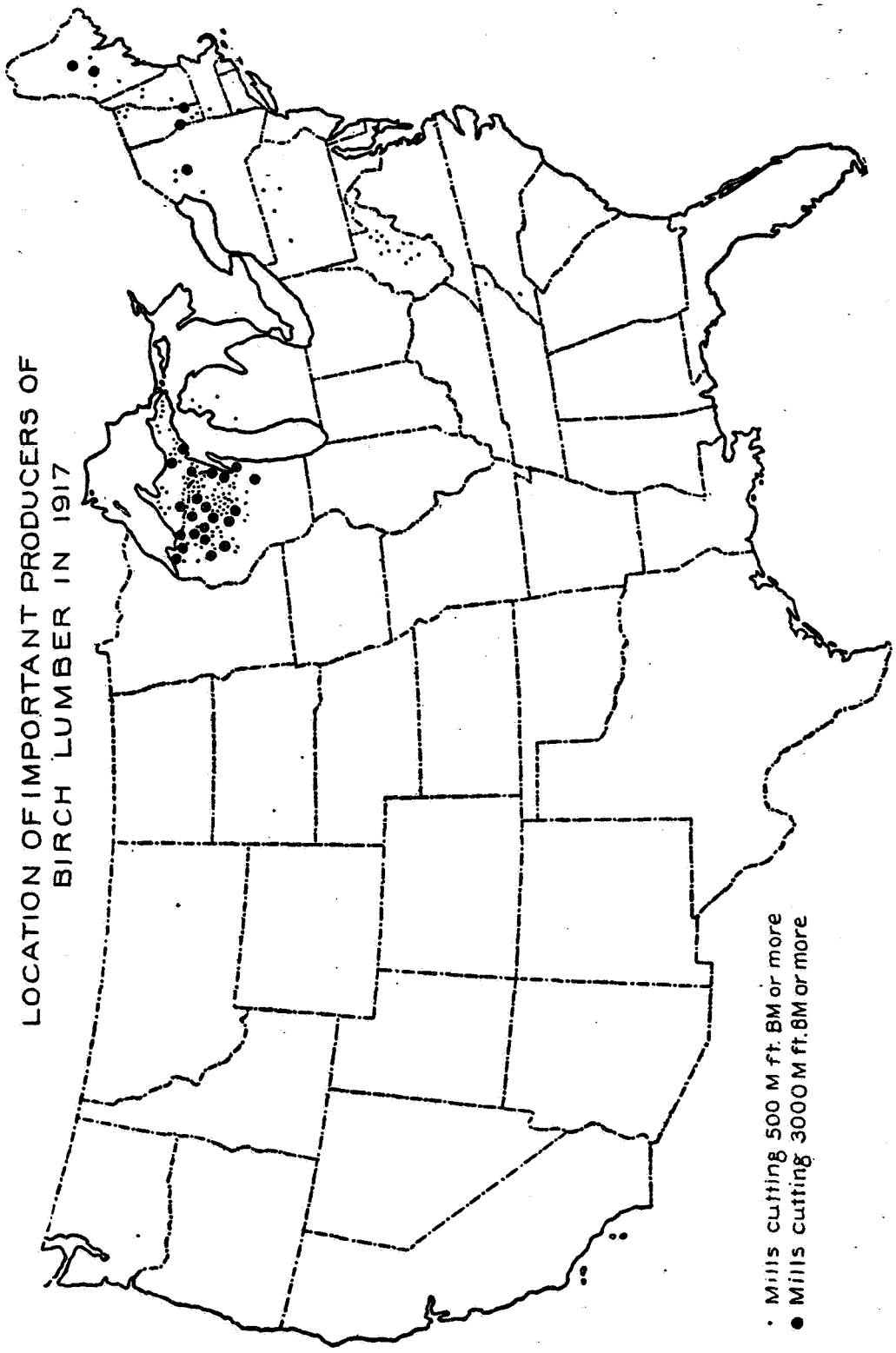
The range of sweet birch extends from Newfoundland to western Ontario, central Iowa, southern Illinois, and south along the Appalachian Mountains to Florida. While most abundant in the North, it reaches its largest size on the western slopes of the southern Appalachians. Yellow birch occurs from Newfoundland to northern New England, northern Minnesota, and south along the Appalachians to Tennessee and North Carolina. It is most abundant and of largest size in northern New England and New York, and in northern Michigan and Wisconsin.

USE IN AIRCRAFT.

Birch of these two species is quite heavy, hard, stiff, and resistant to wear, of uniform texture, and takes a fine finish. It, therefore, makes satisfactory propellers except where the requirements are exceptionally exacting. It has been used for propellers in several countries.

Birch plywood is widely used in the manufacture of aircraft. Because of its resistance to wear, its stiffness, and ease of bending, it is especially good for face ply where thinness is essential.

On account of the fairly large and accessible supplies of birch timber located at no great distance from the centers of manufacture, birch will probably continue to be a very important wood in the aircraft industry.


LOCATION OF IMPORTANT PRODUCERS OF BIRCH LUMBER IN 1917
MAP No. 15
• Mills cutting 500 M ft. BM or more
● Mills cutting 3000 M ft. BM or more

SUPPLY OF TIMBER.

While birch is frequently found in pure or almost pure stands of second growth over small areas, it seldom so occurs in virgin stands, but is mixed with other hardwoods and conifers, among which sugar maple, beech, basswood, hemlock, spruce, and pine are important. Mature sweet birch trees run from 2 to 3 feet in diameter and from 70 to 80 feet in height, while yellow birch averages a little larger.

Much of the virgin birch in northern New England and in the Appalachian region is still somewhat distant from sawmill plants. The birch region of Wisconsin and the adjacent part of upper Michigan is the most fully developed at present.

Estimates of the total stand of birch are very unsatisfactory, and no attempt is made to distinguish the species. The best available figure for all the birches together is approximately 19 billion board feet. This includes several species other than the two under discussion, but the proportion of these (principally paper birch and river birch) is relatively small. The States having the largest stands of birch are, in the order named: Maine, Wisconsin, New York, Michigan, Minnesota, Vermont, New Hampshire, which together have about 90 per cent of the total. It is estimated that there is in New England and New York 10 billion feet, in the Lake States 8 billion feet, and in the southern Appalachians 1 billion feet.

The greater part of the old-growth birch is owned by lumber companies or by land-investment companies, in large or fairly large units.

PRODUCTION OF LUMBER.

The average annual cut of birch lumber in the United States between 1913 and 1917 was 440 million board feet. This is a little in excess of the average cut during the preceding six years. In other words, the production of birch is yet on the increase, and the present rate of output may be expected to be maintained for some years to come. Half of the total is cut in northern Wisconsin, and two-thirds in Wisconsin and Michigan together. After these, the important producing States are: Vermont, Maine, West Virginia, and New York. These six States report more than 90 per cent of the total cut. It is estimated that 85 per cent of the birch cut in Wisconsin and Michigan is yellow birch, and most of the remainder is sweet birch. This proportion is doubtless approximately correct for the other States named.

While birch is cut by a large number of small mills, by far the greater proportion is cut by large mills. In northern Minnesota 97 per cent of the total is produced by mills which cut in excess of a million board feet each, and 99 per cent of the northern Michigan output is cut by mills of that class. About 22 mills in Wisconsin and Michigan and 6 in New England and New York report the production of more than 3 million feet of birch each. Birch is cut along with other species as it comes in the stand. Horse logging is the rule, although some of the larger operators use steam. The largest producers run railroad operations. Logging in the birch region is carried on during most of the year. Birch lumber is ordinarily plain sawed and the largest and best logs are saved for veneer. Under normal conditions, from 25 to 30 million feet a year is used for this purpose. The big mills both in the North and in the Appalachian region use considerable care in grading their lumber.

It is estimated that 12 per cent of the cut will grade firsts and seconds, 8 inches or wider, and that possibly 3½ per cent will be suitable for propellers. Firsts and seconds make up 14 or 15 per cent of the total output in the Lake States, and No. 1 common about 25 per cent.

MARKETS AND USES FOR THE LUMBER.

Practically the entire cut of birch is further manufactured. Planing-mill products, including finish, sash and doors, and similar products, take 28 per cent of it. Furniture including chairs, takes 17.7 per cent and uses a larger quantity of birch than of any other woods except oak, maple, and red gum. The spool and bobbin industry uses 6.9 per cent of the birch cut, a quantity greater than that of all other woods combined. Of all birch cut, 6.1 per cent goes into woodenware and novelties; 3.2 per cent into fixtures; 3 per cent into vehicles; 2.7 per cent into musical instruments; 2.1 per cent into handles; 1.7 into dowels; and 1.6 per cent into boot and shoe findings. Many other industries use smaller amounts. The box and crate industry, which probably uses the greater part of the low-grade lumber as well as some of higher grades, absorbs 18.9 per cent of the total.

The greater part of the output of birch lumber is sold and used in regions fairly close to the places where it is produced.

BLACK CHERRY.

(*Prunus serotina*).

DISTRIBUTION.

Black cherry occurs from Nova Scotia to Dakota, south to Florida and Arizona, and along the mountains to South America. It was formerly abundant and of considerable commercial importance in the Appalachian region from West Virginia to Alabama, but is nowhere abundant now.

USE IN AIRCRAFT.

Cherry wood is strong, fairly hard, straight grained, works well, and takes a fine finish; consequently it is an excellent propeller wood. It is also good for plywood facing. The supply is so small, however, that this species can probably never be of great importance to the airplane industry.

SUPPLY OF TIMBER.

Available estimates of the supply of standing black cherry timber are only rough guesses based on the amounts known to exist in a few localities. There is supposed to be between 400 and 500 million feet all together. Cherry usually occurs scattered as single trees in mixed hardwood forests and along roads and fences. It is estimated that about 100 million feet is in New England and New York, 200 million in the southern Appalachians, and 100 million in the central woodlot region. Probably there is more cherry left in West Virginia than in any other State. New York, Pennsylvania, Ohio, Michigan, Tennessee, North Carolina, and Kentucky are also supposed to have considerable quantities. A few large virgin tracts in the mountains still contain considerable amounts of cherry, but by far the greater part of the supply is in the hands of a multitude of small owners.

PRODUCTION OF LUMBER.

The average annual cut of black cherry lumber in recent years has been less than 10 million board feet, and it is steadily decreasing. West Virginia cuts the most. Other States that produce considerable quantities are: Pennsylvania, New York, North Carolina, Indiana, Tennessee, Michigan, Ohio, and Virginia. About 20 States in all report some cherry cut.

Cherry forms only a very small part of the cut of most of the mills that saw it. It is cut by a large number of both large and small mills, very few of which cut large quantities.

It is estimated that from 15 to 25 per cent of the cut grades firsts and seconds, most of which would be suitable for propellers.

USES FOR THE LUMBER.

Cherry is a valuable cabinet wood, and practically the entire cut is further manufactured. Eighteen per cent goes into fixtures. Seventeen per cent goes into printing material (backing) this industry using more cherry than any other five woods combined. Car construction uses for finish 16 per cent of the cherry lumber cut. Fourteen per cent goes into planing-mill products; 6 per cent into professional and scientific instruments; 5½ per cent into furniture; 5 per cent into handles; 4 per cent into brushes. Musical instruments, clocks, boats, fancy boxes, and patterns take considerable quantities.

ELM.

CORK ELM (*Ulmus racemosa*).

This species is also known as rock elm, cork-bark elm, and hickory elm.

WHITE ELM (*Ulmus americana*).

This species is also known as American elm, water elm, and gray elm.

SLIPPERY ELM (*Ulmus pubescens*).

This species is also known as red elm and rock elm.

WING ELM (*Ulmus alata*).

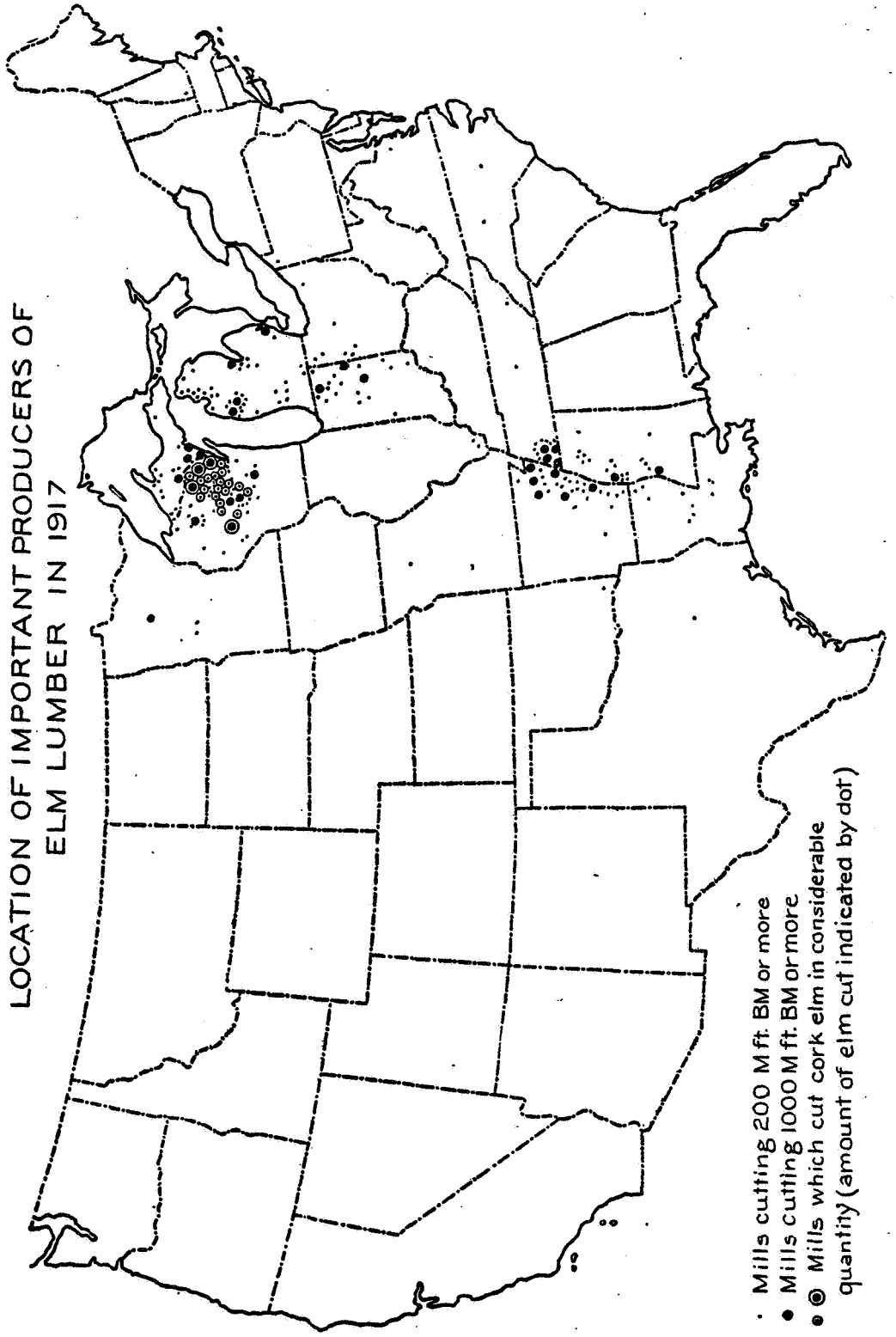
This species is also known as wahoo, witch elm, cork elm, small-leaved elm, red elm, water elm, and mountain elm.

CEDAR ELM (*Ulmus crassifolia*).

This species is also known as red elm and basket elm.

DISTRIBUTION.

Cork elm occurs from eastern Quebec, through northern New Hampshire and Vermont, to Michigan, Wisconsin, northeastern Nebraska, Missouri, and middle Tennessee. It is commercially important chiefly in northeastern Wisconsin and adjacent parts of upper Michigan. White elm occurs from southern Newfoundland to the eastern base of the Rocky Mountains and south to Texas and Florida. Commercially it is most important in Michigan, Wisconsin, Indiana, and


LOCATION OF IMPORTANT PRODUCERS OF ELM LUMBER IN 1917
· Mills cutting 200 M ft. BM or more
• Mills cutting 1000 M ft. BM or more
◉ Mills which cut cork elm in considerable quantity (amount of elm cut indicated by dot)
MAP No. 16

the lower Mississippi Valley. Slippery elm has almost the same range as white elm, but does not extend quite so far north or south. Wing elm occurs in the Atlantic coast region from southern Virginia to Florida, and in the lower Mississippi and tributary valleys from southern Illinois to Texas. Cedar elm occurs from Mississippi through Louisiana, southern Arkansas, and most of the wooded part of Texas.

USE IN AIRCRAFT.

Elm is slightly heavier than ash and rather low in stiffness but very tough and shock resistant. It steam bends very well and may be substituted for ash in longerons and for similar uses. It is also used for other bent work, such as landing skids and flying-boats' keels. Cork elm has been approved for propellers. White elm is used for bent plywood.

Individual pieces of slippery and white elm of the same density as cork elm have the same properties; therefore, the species is a less important consideration than the density. Slippery elm is on the average lighter than cork elm, and white elm is lighter and less stiff. All of the elms require care in drying because of their tendency to warp and to twist.

The supply of cork elm being very limited, this species probably has no future as a propeller wood. On the other hand, the supply of all the elms taken together is comparatively large and accessible, and growth is rapid; therefore, elm for bent work and plywood may be used in increasing quantities.

SUPPLY OF TIMBER.

Elm grows scattered in mixed stands with other hardwoods, and does not form pure stands. It is a very common and widely distributed field and roadside tree. White elm reaches diameters of 6 feet or more at maturity. Cork elm occasionally reaches diameters of 3 feet, while slippery elm and cedar elm are somewhat smaller, and wing elm is rarely 2 feet in diameter. Forest-grown cork elms are frequently free of branches for 60 feet from the ground.

Such estimates as are available of the total stand of elm do not separate the species. It is judged that there is about 16 billion feet of elm standing. The States with the largest supplies of elm are, in the order named: Arkansas, Missouri, Michigan, Louisiana, Mississippi, and Wisconsin. These six States have two-thirds of the total stand. In New England and New York there is slightly less than 1 billion feet, in the Lake States nearly 4 billion feet, in the Mississippi valley 8 billion feet, and in the central woodlot region 3 billion feet. It has been estimated that from one-fourth to one-third of the elm cut in Wisconsin, 5 per cent of that cut in lower Michigan, and 20 per cent of that cut in upper Michigan is cork elm. There is probably about 300 million feet of cork elm standing in these States, which have nearly all of the supply of this species that is commercially important. While most of the remaining forest-grown elm, and probably practically all of the forest-grown cork elm is in large holdings owned by land and lumber companies, a large part of the total stand of elm is held by small owners. Much of it, especially in the lower Mississippi region, is on land that will be cleared for agriculture.

PRODUCTION OF LUMBER.

During the years 1913 to 1917 the average annual cut of elm lumber was about 215 million feet, which is 60 million feet less than the average cut during the preceding six years. The cut is gradually but quite steadily decreasing. Wisconsin and Michigan together produce one-half of the total; following them come Indiana, Arkansas, Ohio, and Missouri. These six States report more than three-fourths of the total. Twenty mills in the North (Minnesota, Wisconsin, Michigan, Indiana) reported cuts of elm for 1917 in excess of 1 million feet; fifteen in the lower Mississippi valley reported similar cuts. From 15 to 20 million feet of elm veneer, not included in the lumber cut, is also produced each year, besides about 150 million feet of slack cooperage material. The annual production of cork elm lumber is about 13¼ million feet, of which 10 million feet is cut in Wisconsin, nearly all in Shawano, Langlade, and Forest Counties, and 3¼ million feet in Michigan. About half the elm cut in the three Wisconsin counties named is cork elm. Elm lumber forms only a minor part of the total cut of the larger mills reporting, as few, if any, of them make any special effort to get elm except as they happen upon it in the course of logging.

Practically all elm logs are plain sawed. From 18 to 20 per cent of the cork elm cut grades firsts and seconds, admitting widths as narrow as 4 inches, and from 24 to 30 per cent grades No. 1 common. The total amount of plain-sawed, straight grained, clear cork elm, suitable for propellers, that can be obtained from the present annual cut, it is estimated, will not exceed about 200 thousand board feet. This is only about 1½ per cent of the total cut. It is probable, however, that a much larger proportion, possibly from 15 to 20 per cent, will be suitable for other parts of aircraft. Because of the larger average size of the logs, an even greater part of the cut of white elm may be available for those uses to which this species is adapted, including the making of veneers. A comparatively small percentage of it will be of sufficient density to make longeron stock.

MARKETS AND USES FOR THE LUMBER.

At least 90 per cent of the elm lumber cut is further manufactured before it reaches the consumer. Twenty-six per cent goes into boxes and crates; 14 per cent into furniture (principally chairs, for which more elm is used than any other wood except maple and beech); 12½ per cent into vehicles; 6½ per cent into musical instruments; 5 per cent into refrigerators and kitchen cabinets; 3 per cent into agricultural implements; and 2½ per cent into trunks (especially slats). Smaller quantities are used for a great variety of products.

This wood is practically all used in the Northern and Eastern States, and the industries which take the largest amounts of elm are usually located fairly close to the sources of supply. A great deal of the cooperage material is manufactured into finished products in the South, near the places where it is cut.

A large part of the cork elm produced is used in vehicles, for hubs, bows, parts of the running gear, automobile bodies, logging-wheel spokes, sleigh runners, and carriage-wheel rims. Some is used for chair rockers, stepladders, ladder rungs, plow handles, scythe snaths, and many other articles.

HICKORY.

SHAGBARK HICKORY (*Hicoria ovata*). SHELLBARK HICKORY (*Hicoria laciniosa*). PIGNUT HICKORY (*Hicoria glabra*). MOCKERNUT HICKORY (*Hicoria alba*). BITTERNUT HICKORY (*Hicoria minima*). WATER HICKORY (*Hicoria aquatica*). NUTMEG HICKORY (*Hicoria myristicaeformis*). PECAN HICKORY (*Hicoria pecan*).

There are several other hickory species of minor importance, but the greater part of the lumber cut is from the first five species.

DISTRIBUTION.

Shagbark hickory occurs from southern Maine through southern Quebec and Ontario to southern Minnesota and eastern Nebraska, and south to Delaware, and along the Appalachians to western Florida and Texas. It is most abundant on the western slopes of the southern Appalachians and in the lower Ohio Valley. Shellbark hickory is found from central New York to eastern Nebraska, and south to North Carolina and Oklahoma, and is most abundant in the bottom lands of central Missouri and the lower Ohio Basin. Pignut occurs from southern Maine to Nebraska and south to the Gulf of Mexico. It is most abundant in Missouri and Arkansas, and grows to largest size in the lower Ohio River Basin. Mockernut occurs from southern Ontario to Kansas and south to Florida and Texas, and is abundant in the lower Ohio Valley, Missouri, Arkansas, and the South Atlantic and Gulf costal regions. Bitternut covers about the same range as pignut, except that it is not found quite so far south. It is abundant in all of the Central and Northeastern States, and is the most common hickory of Iowa, Nebraska, Kansas, and southern New England. Water hickory grows in swamps of the coastal plain from southern Virginia to Texas and up the Mississippi Valley to southern Illinois. It is most abundant in Louisiana, Arkansas, and Mississippi. Nutmeg hickory is found from South Carolina to Mexico, and is most abundant in southern Arkansas. Pecan occurs in the Mississippi Valley from Iowa to Texas, east to southern Indiana and central Alabama, and west to eastern Kansas and Oklahoma.

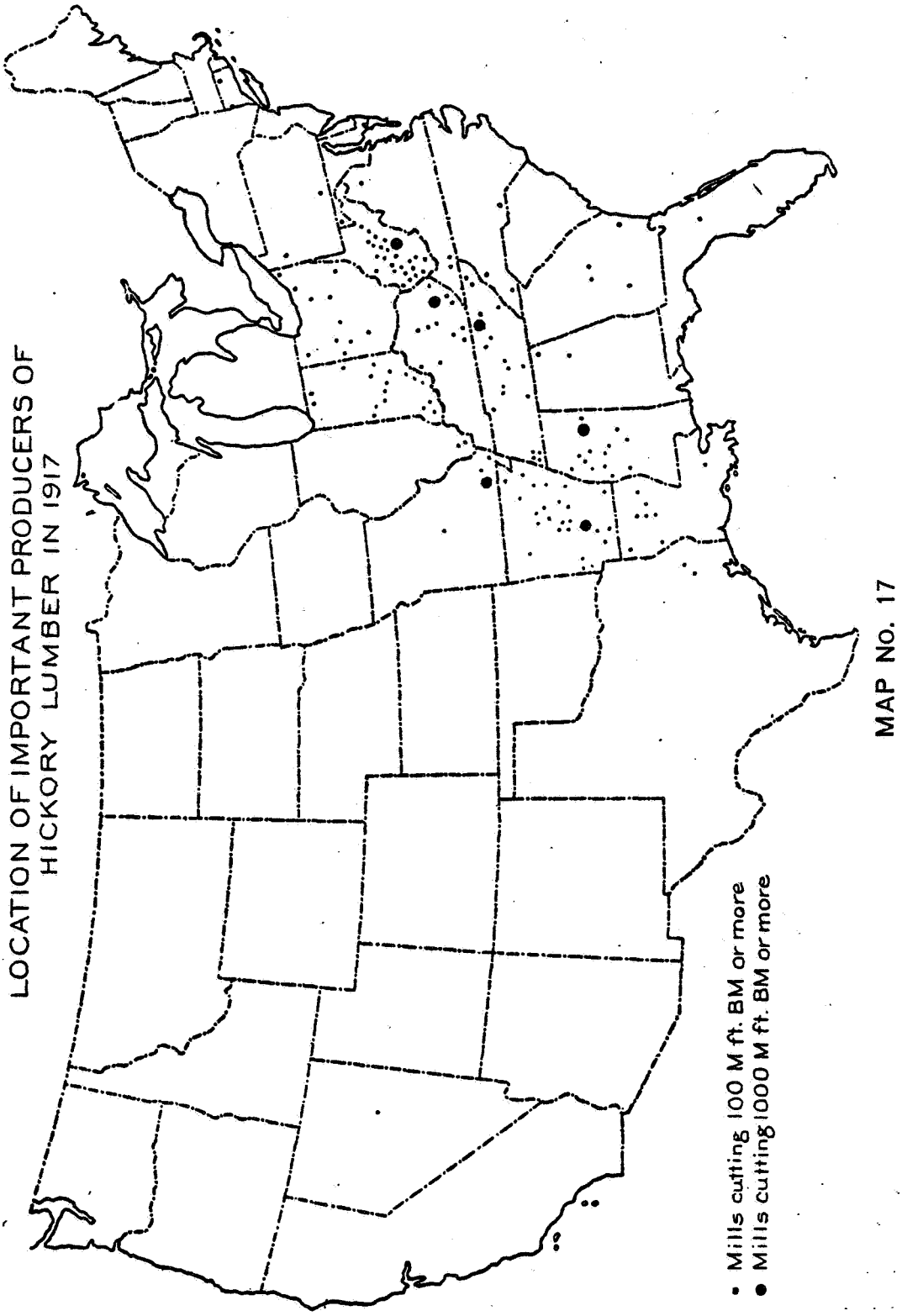
USE IN AIRCRAFT.

Wood of the first four species named above has been suggested as a possible substitute for ash in longerons, since it is tough and strong, though heavier than ash. So far as known, hickory has not been used for longerons. It is used to some extent for landing skids. The other species are less shock resistant and considerably inferior to these four.

SUPPLY OF TIMBER.

Hickory usually occurs scattered singly or in groups through mixed hardwood forests at low and medium elevations. Over limited areas it is frequently the predominant species. While it is fairly common throughout most of its range except in the higher mountains, it is most abundant and of best quality in the rich bottom lands of the Mississippi and Ohio Rivers and their tributaries. In this region, as well as in the southern Applachians, there are still large supplies of virgin timber. In the rest of the country most of the hickory is second growth, which, however, is considered to be fully as desirable as old-growth timber.

The total stand of hickory can only be guessed at. The best available estimate places it at about 16 billion board feet, of which 3 billion feet is in the central woodlot region, 2½ billion feet in the southern Appalachians, 2½ billion feet in the Atlantic and Gulf coastal region, and 7 billion feet in the lower Mississippi Valley region. The States with the largest supplies of hickory are, in about the following order: Arkansas, Missouri, Tennessee, Kentucky, North


LOCATION OF IMPORTANT PRODUCERS OF HICKORY LUMBER IN 1917
• Mills cutting 100 M ft. BM or more
● Mills cutting 1000 M ft. BM or more
MAP No. 17

Carolina, Louisiana, Mississippi, Alabama, and West Virginia. These nine States have about two-thirds of the total stand.

The standing hickory is in the possession of a considerable number of large owners as well as of a multitude of smaller holders. It is a very common and widely scattered wood-lot tree, and occurs in large quantities on the holdings of lumber companies throughout the South.

PRODUCTION OF LUMBER.

A large part of the hickory used in the United States does not go through regular sawmills, but is cut directly into planks, squares, or billets, which are manufactured into spokes, handles, rims, and other products. For this reason the census figures on the production of hickory lumber do not give a sum anywhere near the total production of hickory used in the industries. During the years 1913 to 1917 the average cut of hickory lumber was about 120 million board feet, and this is less than half the average annual cut from 1907 to 1912, which was 254 million feet. The cut is steadily declining.

Arkansas, Tennessee, West Virginia, Mississippi, Kentucky, Indiana, and Ohio lead in the production of hickory lumber, and together produce nearly three-fourths of the total. Mississippi, Ohio, Louisiana, Missouri, and Pennsylvania are also important producing States.

Hickory from virgin forests such as are found in the southern Appalachians and in the lower Mississippi region, is cut in considerable quantities by large hardwood mills, which take it along with their other timber. The great bulk of the hickory production, however, comes from small or medium-sized mills. Many small operators specialize on hickory squares and billets, which are not recorded in lumber census reports. For the year 1917, only six mills reported cuts of more than a million board feet of hickory lumber, while about 150 reported cuts between 100 thousand and 1 million feet.

The proportion of the hickory cut that would be suitable for airplane work depends very largely upon the sizes in which it would be wanted. For short, narrow strips, such as are used for skids, a very large part of the cut would be suitable.

MARKETS AND USES FOR THE LUMBER.

Available figures on the amounts of hickory used about six years ago by various industries indicate a total consumption of 390 million board feet, which is 50 per cent, or 130 million feet, in excess of the average lumber cut for the five years previous to that time. The total cut of hickory lumber has fallen off to about 40 per cent of what it was then, but it is not known whether or not the total consumption of hickory has fallen off to the same extent.

Of the total of 390 million feet, 62 per cent was used by the vehicle industry, which took more hickory than any other wood, and, with the exception of oak, more hickory than all other woods combined. Handle manufacturers used 31 per cent of the total. Forty-three per cent of all wood used for handles was hickory. Agricultural implements took about 2½ per cent, athletic goods, 1½ per cent, and numerous other industries, small quantities.

Most of the hickory cut is used in the woodworking centers of the Central and Eastern States. In 1913 about 8 million feet of hickory in the log was exported, and this went chiefly to Canada, South Africa, Australia, and Germany.

SUGAR MAPLE.

(*Acer saccharum.*)

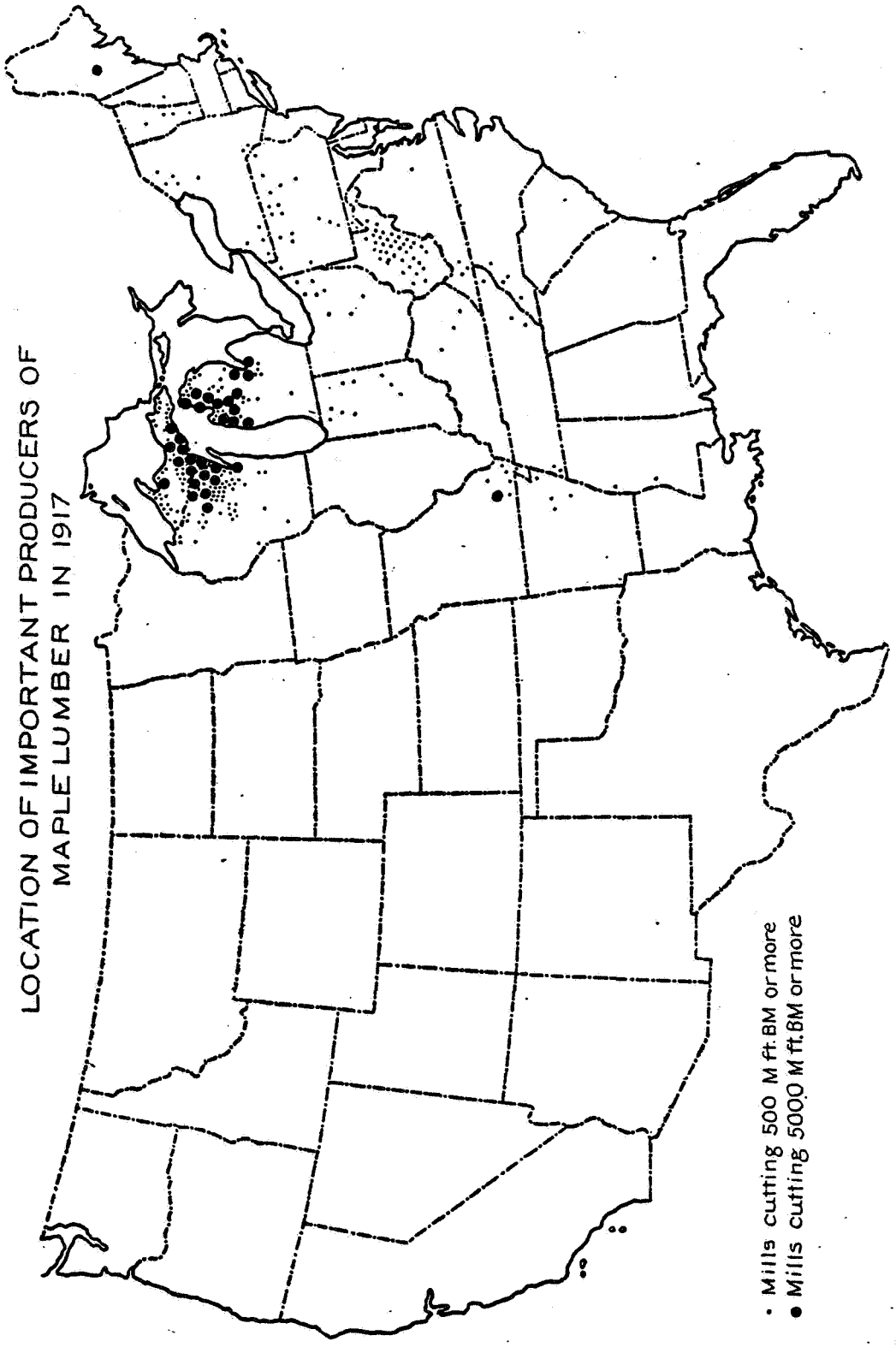
This species is also known as hard maple, rock maple, and black maple.

DISTRIBUTION.

The range of sugar maple extends from southern Newfoundland to Minnesota, and south to eastern Texas and northwestern Florida. It is of commercial importance chiefly in the Lake States, the Northeast, and along the Appalachian Range to northern Georgia. The best maple comes from Michigan, especially from the lower peninsula.

USE IN AIRCRAFT.

Sugar maple, being quite heavy, hard, stiff, resistant to wear, and of uniform texture, is a fairly satisfactory propeller wood, and has been so used where the requirements were not too exacting. Because of the same qualities it makes excellent face ply and finish. It has also been approved for bent work, skids, and engine bearers. Its comparative abundance, wide distribution, accessibility, and comparative cheapness promise for it an important future in airplane manufacture.


LOCATION OF IMPORTANT PRODUCERS OF MAPLE LUMBER IN 1917
• Mills cutting 500 M ft. BM or more
● Mills cutting 5000 M ft. BM or more
MAP No. 18

SUPPLY OF TIMBER.

Sugar maple occurs scattered singly or in groups through mixed stands of hardwoods, most important of which are birch, beech, and basswood, and in stands of hemlock and white pine. It seldom forms a large proportion of the stand, except over very limited areas. Mature trees ordinarily run from 30 to 40 inches in diameter and from 100 to 120 feet in height, often with clear boles of 60 feet or more when grown in the forest. Most of the maple is so situated that it can be logged without any great difficulty, although much of it is not tributary to existing mills. It has been estimated that between 10 and 15 per cent of the remaining stand will be cut in operations now in progress.

Accurate data on the total stand of maple timber are lacking, as is the case with most of our species. The best available estimates indicate that there is between 40 and 50 billion board feet of merchantable size (including both sugar maple and the soft maples), of which one-fourth is in Michigan, and nearly three-fourths in the following nine States: Michigan, New York, Missouri, Maine, Wisconsin, Arkansas, Ohio, Vermont, and Pennsylvania. In Missouri and Arkansas soft maple is prevalent; in the other States named, sugar maple predominates. About 12 billion feet is standing in New England and New York, 15 billion feet in the Lake States, and 6 billion feet in the Appalachian region.

While there is a large quantity of maple in the aggregate on farmers' woodlots and similar small holdings in the maple region, most of it is more or less open-grown, short-boled timber which will not produce a large proportion of airplane material. Probably the greater part of such material will come from virgin forest stands such as exist in northern New England, New York, the Lake States, and along the Appalachians, and are largely owned in fair-sized blocks by lumber or land companies.

PRODUCTION OF LUMBER.

The annual cut of maple lumber in the United States averaged from 1913 to 1917, inclusive, about 900 million board feet, of which it is estimated about 80 per cent was sugar maple. The cut from 1907 to 1912 averaged a little less than a billion feet a year. While there is , therefore, a gradual decline in production, the rate is still quite well maintained. Forty per cent of the cut comes from Michigan and seven-tenths from the three States of Michigan, Wisconsin, and West Virginia. In Michigan and Wisconsin more than 95 per cent of the cut is made by large mills whose production is in excess of one million feet of maple each; in West Virginia about 80 per cent is cut by such mills. The larger concerns, as a rule, grade their lumber more carefully than the smaller ones and are better equipped to turn out well-manufactured, high-grade material in quantity.

Logging is carried on throughout the year in most operations, and horse logging is the rule, although a few of the larger operators use steam. Railroads are employed in many of the large enterprises.

The proportion of the cut which is suitable for use in aircraft depends, of course, upon the purpose for which it is wanted. It is estimated that about 3 per cent will be of the size and quality suitable for propellers if plain-sawed material is used, or 1 to 1½ per cent if quarter-sawed material is required. About 15 per cent of the entire cut, or of that part of it produced by larger mills at least, is in the two upper grades of firsts and seconds, while about 25 per cent is No. 1 Common. From 30 to 40 million feet of maple is normally cut into veneer.

MARKETS AND USES FOR THE LUMBER.

More than 90 per cent of the cut of maple lumber is further manufactured. Perhaps the most important use of high-grade sugar maple is for flooring. Of the total cut of all species of maple, 31.6 per cent is made into planing mill products, including flooring. In quantity, the maple manufactured by planing mills is exceeded among hardwoods only by oak. Of the maple lumber cut, 13.5 per cent is utilized for furniture and chairs, and the amount of it used for this purpose is exceeded only by oak. For boot and shoe findings, 5.4 per cent of the maple cut is used. This is 81 per cent of all the lumber taken by this industry and does not include the large amount of maple so used without being cut into lumber. In the making of agricultural implements 4.8 per cent of the maple cut is employed. Oak and yellow pine are the only woods used more extensively in this industry than maple. More maple than any other wood is utilized in making musical instruments, the percentage being 4.5 of the total cut. For the manufacture of handles 4.1 per cent of the maple cut is taken, and only hickory and ash are used in larger amounts than maple in this industry. In the making of vehicles, and especially for the framework of trucks and automobiles, 3.6 per cent of the maple cut is employed. Two per cent of the maple cut is made into fixtures, and oak is the only wood used more largely than maple for this purpose. Large quantities are used for woodenware, laundry appliances, spools and bob-

bins, refrigerators, car construction, trunks, sporting goods (exceeded only by hickory), professional and scientific instruments (exceeded only by cedar used for pencils), and toys. The box and crate industry uses 9.6 per cent of the cut.

Maple flooring is sold all over the country. The maple used by the various industries is sold largely in the Central and Northeastern States where these industries are centered; consequently, very long railroad hauls are not ordinarily necessary.

OAKS.

WHITE OAKS: WHITE OAK (*Quercus alba*). POST OAK (*Quercus minor*). BUR OAK (*Quercus macrocarpa*). COW OAK (*Quercus michauxii*). OVERCUP OAK (*Quercus lyrata*). CHESTNUT OAK (*Quercus prinus*).
RED OAKS: RED OAK (*Quercus rubra* or *borealis*). TEXAN OAK (*Quercus texana*). PIN OAK (*Quercus palustris*). SCARLET OAK (*Quercus coccinea*). YELLOW (or BLACK) (*Quercus velutina*). WILLOW OAK (*Quercus phellos*).

These twelve species furnish the greater part of the oak lumber cut in the United States. A few other species in each group furnish small quantities.

DISTRIBUTION.

Taken together, the species named are widely distributed throughout the United States east of the Great Plains. Numerous species of scrub oaks of little or no value for lumber occur in the southern Rocky Mountain, Great Basin, and Pacific coast regions, while several species that do produce some lumber occur in California and Oregon.

White oak occurs from southern Maine to southern Michigan, southern Minnesota, eastern Nebraska, and Kansas, and south to Texas and Florida. It is most abundant and of greatest commercial importance on the western slopes of the southern Appalachians and in the lower Ohio Valley bottomlands. Post oak occurs from southern Massachusetts to Florida and west to Missouri and Texas, and is of greatest commercial importance on dry uplands of the Mississippi basin. Bur oak occurs from Nova Scotia and New Brunswick to southern Manitoba and eastern Montana, and south to central New England, Pennsylvania, central Tennessee, and Texas. It is of greatest commercial importance in southern Indiana, Illinois, and Missouri. Cow oak occurs on bottomlands in the Coastal Plain and Mississippi Valley regions from Delaware to Texas and northward as far as southern Illinois and Indiana. It is of greatest commercial importance in the lower Mississippi Valley. The range of overcup oak extends from Maryland through southern Indiana to southern Missouri and south to Florida and Texas. It is most abundant in the lower Mississippi Valley and Gulf regions. Chestnut oak occurs in the Appalachian region from central New England to Alabama, and is most important commercially in the Carolinas and Tennessee.

Red oak ranges from Nova Scotia to north of Lake Huron, central Kansas, and along the mountains to Georgia. It is commercially important chiefly in the Northeastern States. Texan oak occurs in the Mississippi Valley from Iowa to Texas and up the Atlantic coast to North Carolina, and is of greatest commercial importance on the lower Mississippi bottomlands.

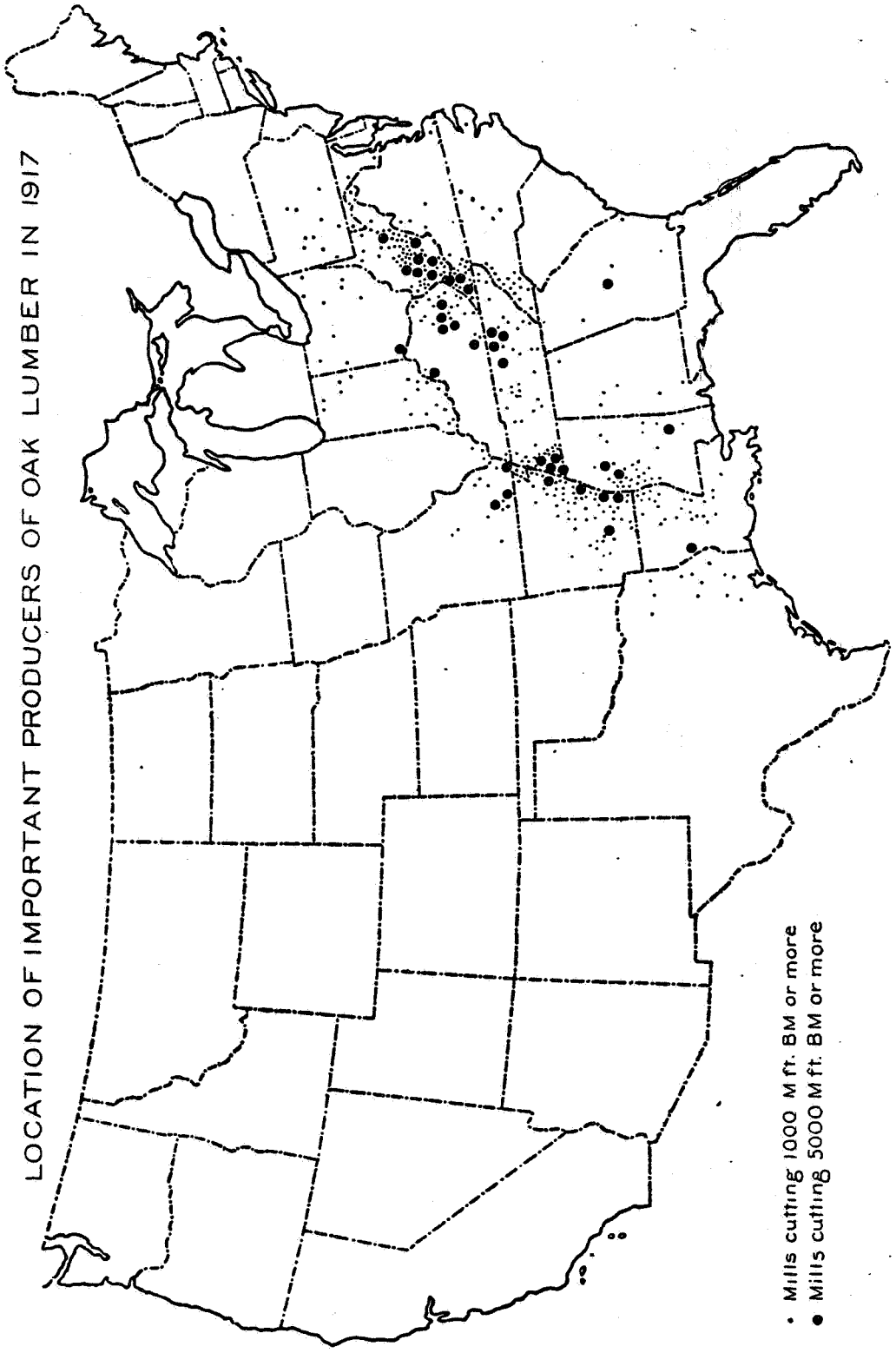
Pin oak occurs from southwestern New England to southern Missouri and southward to Virginia, Kentucky, and northern Arkansas, and is most abundant in the lower Ohio basin. Scarlet oak occurs from southern Maine to Nebraska, south to Illinois and the District of Columbia, and along the mountains to North Carolina. It is most abundant in the Atlantic coast region from Massachusetts to southern New Jersey. Yellow oak occurs from southern Maine to central Minnesota, and southward to northern Florida and eastern Texas. It is common throughout most of its range. Willow oak grows in bottomlands of the Coastal Plain region from Staten Island to Texas and up the Mississippi Valley to Missouri and Kentucky.

USE IN AIRCRAFT.

The white oaks shrink and swell with the weather less than do the red oaks. They glue well, finish well, and are very strong. The first four species named have long been approved as propeller woods. For propellers, quarter-sawed material is considered much superior to plain-sawed, because it shrinks less in a radial direction. There has been, so far, considerable prejudice against southern-grown white oaks. Whether this prejudice is justified is not yet fully known, but, with improved technique in the drying and working of lumber from these species it is probable that they may make satisfactory propeller woods.

The red oaks have not so far been used to any extent for propellers. It is possible, however, that selected, quartered red oak, at least of the northern species, may be found satisfactory. There is considerable variation in the strength properties of red oak lumber, even of one species. Moreover, red oak is more likely to be defective than white oak.

White oak of the four approved species has also been approved for structural and bent work on wings and fuselages.


LOCATION OF IMPORTANT PRODUCERS OF OAK LUMBER IN 1917
• Mills cutting 1000 M ft. BM or more
● Mills cutting 5000 M ft. BM or more
MAP No. 19

SUPPLY OF TIMBER.

Oak occurs throughout most of its range on nearly all sites except the highest slopes and ridges. In the extreme northern part of the United States it does not make up an important proportion of the stand; but the proportion of oak increases to the southward, and from southern New England and the Central States to the Gulf the oaks are a very important part of the hardwood forests. In much of the region there is more oak than all other hardwood species combined. Thus the oak lumber cut in the States of Delaware, Maryland, Virginia, Illinois, Kentucky, Tennessee, Missouri, Oklahoma, and Texas exceeds the cut of all other hardwoods, while there is almost as much oak cut as all other hardwoods combined in New Jersey, Pennsylvania, North Carolina, Georgia, Alabama, West Virginia, Ohio, Indiana, and Arkansas.

Only very rough estimates of the stand of oak are available, and these do not distinguish the different species. It has been judged that about 47 per cent of the volume of all oaks belongs in the white oak group, and 53 per cent in the red oak group. White oak proper comprises nearly 22 per cent of the total, and the four species that have been approved for propellers constitute approximately one-third of the total stand of oak, which is estimated to be between 150 and 175 billion board feet.

About 40 per cent of the stand of oak is in the lower Mississippi Valley region, 25 per cent in the southern Appalachain region, and 15 per cent in the central woodlot region. Even in the Northeast and in the woodlot region, there are still some virgin stands of oak, which have been preserved for various reasons. Most of the old-growth oak, however, is now in the South.

PRODUCTION OF LUMBER.

During the period 1913 to 1917 the average annual cut of oak lumber of all species was approximately 3 billion board feet, which is 800 million feet less than the average cut during the preceding six years. The general tendency indicates a steady decline in the production of oak, as the virgin supplies become more nearly exhausted. Less than half as much oak lumber was produced in 1917 as in 1907. Besides the oak sawed into lumber, a great deal that is fit for lumber is sawed into ties, rived into staves, or used for veneer. From 30 to 50 million feet of white oak is made into veneer every year, while the white oak hewed into ties would produce from 500 to 1,000 million board feet of lumber. Nearly half of the oak lumber is produced in West Virginia, Tennessee, Arkansas, and Kentucky, and eight-tenths of the total comes from these States together with Virginia, Mississippi, Missouri, North Carolina, Pennsylvania, and Ohio.

More than half of the sawmills in the United States saw oak lumber. These include the very smallest mills as well as some of the largest. For the year 1917, 22 mills in the southern Appalachian region and 16 in the lower Mississippi Valley region reported cuts of more than 5 million feet of oak each, while some 330 reported cuts of between 1 and 5 million feet each. Most of these mills cut other species as well as oak; a few make oak a specialty.

Logging in most of the oak region is carried on during the greater part of the year, though more timber is cut in the fall and winter than during the spring and summer months. The small operators and many of the larger ones use animals for logging, and haul logs to their mills by wagon, truck, or rail. Many of the large concerns in the South log with steam, and most of them operate logging railroads. A few establishments, particularly in the farming sections, buy logs from farmers and contractors.

It has been estimated that at the present time about 58 per cent of the oak lumber cut is white oak. Of this about 27 per cent is cut into sawed ties and large timbers, and 20 per cent of the remainder grades firsts and seconds. To get quarter-sawed material 8 inches or more wide, such as is wanted for propellers, logs 23 inches or more in diameter are required. Approximately 15 per cent of the firsts and seconds cut by the larger mills will make quarter-sawed propeller material. About two-thirds of the white oak is cut by these larger mills, the very small mills not being equipped for quarter-sawing. On this basis, about 0.85 of 1 per cent of the total oak lumber cut will be suitable for propellers. Of course, the proportion of such material produced by different operators will vary widely. Mills that buy selected logs can cut a very much higher proportion than those that cut their own logs as they come to them.

MARKETS AND USES FOR THE LUMBER.

American oak lumber is sold all over the United States and in many foreign countries. During the fiscal year 1913, in round numbers, 3 million feet of oak logs and 300 million feet of oak lumber was exported from the country. By far the greater part of the oak used in the United States is sold in the territory east of the Mississippi and north of the Ohio and Potomac Rivers.

Nearly 40 per cent of it goes into ties, timbers, and rough lumber; 18 per cent into furniture; 16 per cent into planing mill products (flooring, interior finish, etc.); about 10 per cent (chiefly low-grade material) into boxes and crates; 7 per cent into vehicles; 2 per cent each into agricultural implements, fixtures, and railway cars; 1 per cent each into shipbuilding and refrigerators; and smaller amounts into most of the other industries which use wood.

High-grade white oak of large sizes, which will yield propeller material, is cut largely into lumber for furniture, railway cars, and shipbuilding, or into veneers. A considerable quantity, particularly in the South, is rived into staves for tight cooperage.

YELLOW POPLAR.

(*Liriodendron tulipifera.*)

This species is also known as tulip poplar, tulip tree, white wood, and hickory poplar. Cucumber (*Magnolia acuminata*) and evergreen magnolia (*M. foetida*), which are usually cut and sold with poplar and have about the same strength properties, are included with it in the following discussion.

DISTRIBUTION.

Yellow poplar occurs in all States east of the Mississippi River except Maine, New Hampshire, Vermont, and Wisconsin, and occurs also in Missouri, Arkansas, and Louisiana. Cucumber does not occur quite so far to the northeast and to the south as poplar. Evergreen magnolia is found principally in the southern Atlantic and Gulf coast regions. Virgin stands of poplar containing large-sized timber are now to a considerable extent confined to the Appalachian region southward from Pennsylvania, and to bottomlands of Tennessee, Georgia, and Alabama.

USE IN AIRCRAFT.

Yellow poplar has been used with satisfactory results for most of the wooden parts of aircraft. While a little heavier than spruce and inferior to it in shock resistance, it is comparatively strong, free from checks and shake, retains its shape well, and is easy to work. It is a fairly satisfactory substitute for spruce in making wing beams and struts, as well as for wing ribs, and has been used to some extent for propellers, particularly by the French. It makes excellent cores for plywood and has been so utilized in considerable quantities.

Its wide distribution, its accessibility, its occurrence within easy reach of centers of aircraft manufacture, as well as its excellent qualities, make yellow poplar a very important species for aircraft construction.

SUPPLY OF TIMBER.

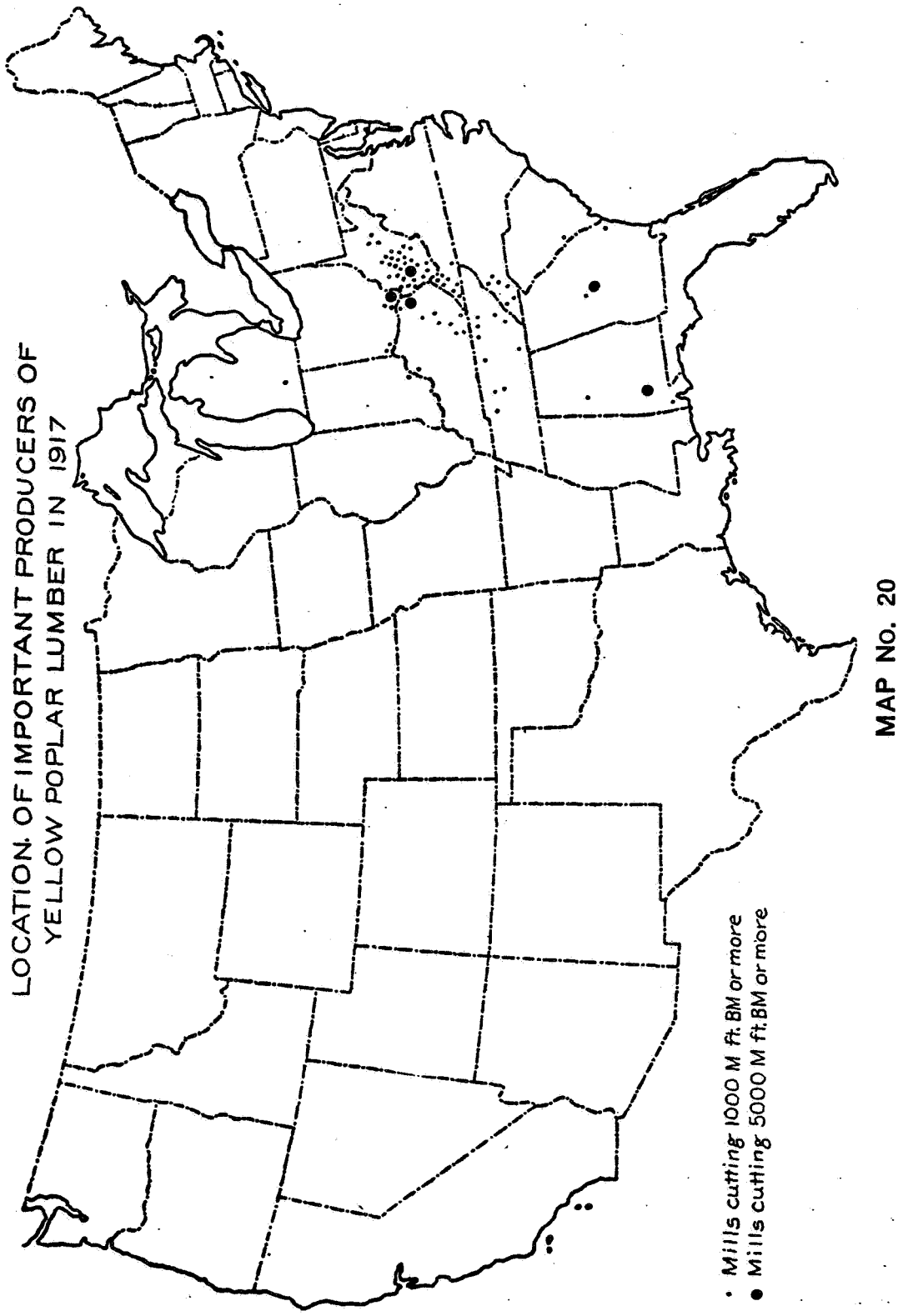
Yellow poplar never occurs in pure stands over considerable areas, but appears as scattered individuals or groups in forests of mixed hardwoods, or of hardwoods and hemlock, pine, or occasionally spruce. In the southern Appalachians, the region of its greatest abundance, it constitutes from 10 to 30 per cent of the stand in virgin timber, or from 1 to 3 thousand board-feet per acre over extensive areas. Occasionally single acres have been reported having as much as 75,000 board feet. In the bottomlands farther south a smaller proportion of the stand is poplar. In virgin stands trees average from 30 to 36 inches in diameter, with 50 to 60 feet clear of branches; diameters of 6 feet are by no means rare.

Poplar is a tree of the lower and middle slopes and coves, and, therefore, to a considerable extent is in fairly accessible places. However, part of the region where it grows is not yet provided with road or railroad facilities, and it is estimated that not more than half of the remaining virgin stand is accessible to existing sawmills.

The total amount of standing poplar is not known. Rough estimates place it at about 9¾ billion board feet, of which perhaps 7 billion feet is virgin timber. Three-fourths of the total stand is in the States of West Virginia, North Carolina, Tennessee, Kentucky, and Virginia. All but a few million feet is in private ownership. The greater part of the remaining virgin timber is in fairly large holdings of lumber companies, coal companies, and land investment companies. Second-growth stands are held by the large companies and by many small owners in different parts of the poplar region.

PRODUCTION OF LUMBER.

The annual cut of yellow poplar lumber from 1913 to 1917 averaged 480 million board feet, and is steadily declining. About one-half as much is now cut each year as was produced ten years ago. West Virginia now produces one-fourth of the total, and is followed by Tennessee, Kentucky, Georgia, Virginia, North Carolina, and Alabama, in the order named. These States produce more than 90 per cent of the total cut.


LOCATION OF IMPORTANT PRODUCERS OF YELLOW POPLAR LUMBER IN 1917
· Mills cutting 1000 M ft. BM or more
● Mills cutting 5000 M ft. BM or more
MAP No. 20

About one-half of the total is cut by large, well-equipped mills of which there are approximately 75 cutting more than one million feet of poplar each. Another one-fourth of the total is cut by some 350 medium-sized or large mills, each of which cuts in excess of 100,000 board feet of poplar. Small mills cut the rest, mostly from second-growth stands which produce very little high-grade lumber. Except for a few which buy logs and specialize on poplar, all of these mills cut a variety of species, and take poplar only as it comes in the stand. Of the lumber cut by the 75 largest producers, 18 per cent was poplar, and by the smaller producers, about 7 per cent. On the basis of their rated capacity and these proportions of poplar, large mills are capable of producing 275 million feet of poplar, while the medium-sized mills could produce 150 million feet. The smaller mills, which now cut less than 100 thousand feet of poplar each, could probably produce 100 million feet a year if operated to their full capacity.

At the present rate of cutting, the existing larger mills have sufficient standing poplar to last them, on the average, from 10 to 12 years. It seems probable that, after the next 15 to 20 years, almost the entire cut will come from small mills and largely from second-growth stands.

Logging is now done with steam quite generally in the southern part of the poplar region, while horses are commonly used in West Virginia. Practically all of the large operations employ railroads. A few operators use motor trucks to some extent to bring in logs, and several large companies along the Ohio River, depend upon water transportation. Operations are carried on throughout the year, although it is customary to try to log the greater part of the poplar in fall and winter, on account of the tendency of logs to sapstain when they are cut during the summer. Logs are seldom cut more than 16 feet in length, though longer ones can be gotten out by the larger operators when such material is wanted.

Under normal conditions no particular effort is made to saw straight-grained material, but the larger producers use considerable care to saw lumber of the upper grades. Poplar is characteristically straight grained, with little taper, so that probably 75 per cent of the clear lumber produced has grain straight enough to make it suitable for aircraft use.

Most of the airplane material will probably come from the upper grades, including panel, wide No. 1, firsts and seconds, and saps and selects. The proportion of this material that is produced varies widely with different stands and regions. The average figure for the large mills is about 26 per cent, and it is estimated that perhaps 75 per cent of this amount will be suitable for airplanes. Probably not more than 5 or 6 per cent of the material from second-growth stands will meet present airplane standards. It is judged that approximately 60 million board feet of the present cut of 350 million feet will fulfill the requirements for airplane work if it is sawed to the desired sizes.

In addition to the above lumber cut, from 25 to 35 million feet of yellow poplar, chiefly high-grade material, is ordinarily cut into veneer each year. Much of this is suitable for airplane plywood.

MARKETS AND USES FOR THE LUMBER.

Practically the entire cut of yellow poplar is further manufactured, and it is used by a very great variety of industries. Thirty-three per cent of the cut is made into sash, doors, finish, siding, and other planing mill products. For furniture, including chairs, 7½ per cent is used. Seven per cent goes into vehicles, and only hickory and oak are used in larger quantities by this industry. Six per cent is employed in making musical instruments. In this industry, maple is the only wood more largely used than poplar. For car construction, 4½ per cent of the poplar cut is taken, and oak is the only hardwood more extensively employed. In manufacturing bungs and faucets, 2½ per cent of the poplar is utilized—86 per cent of all the wood used by this industry. Two per cent is made into fixtures, and the same amount into agricultural implements. A large number of industries use smaller quantities. Box and crate manufacturers take 23 per cent of the cut, mostly low grade material.

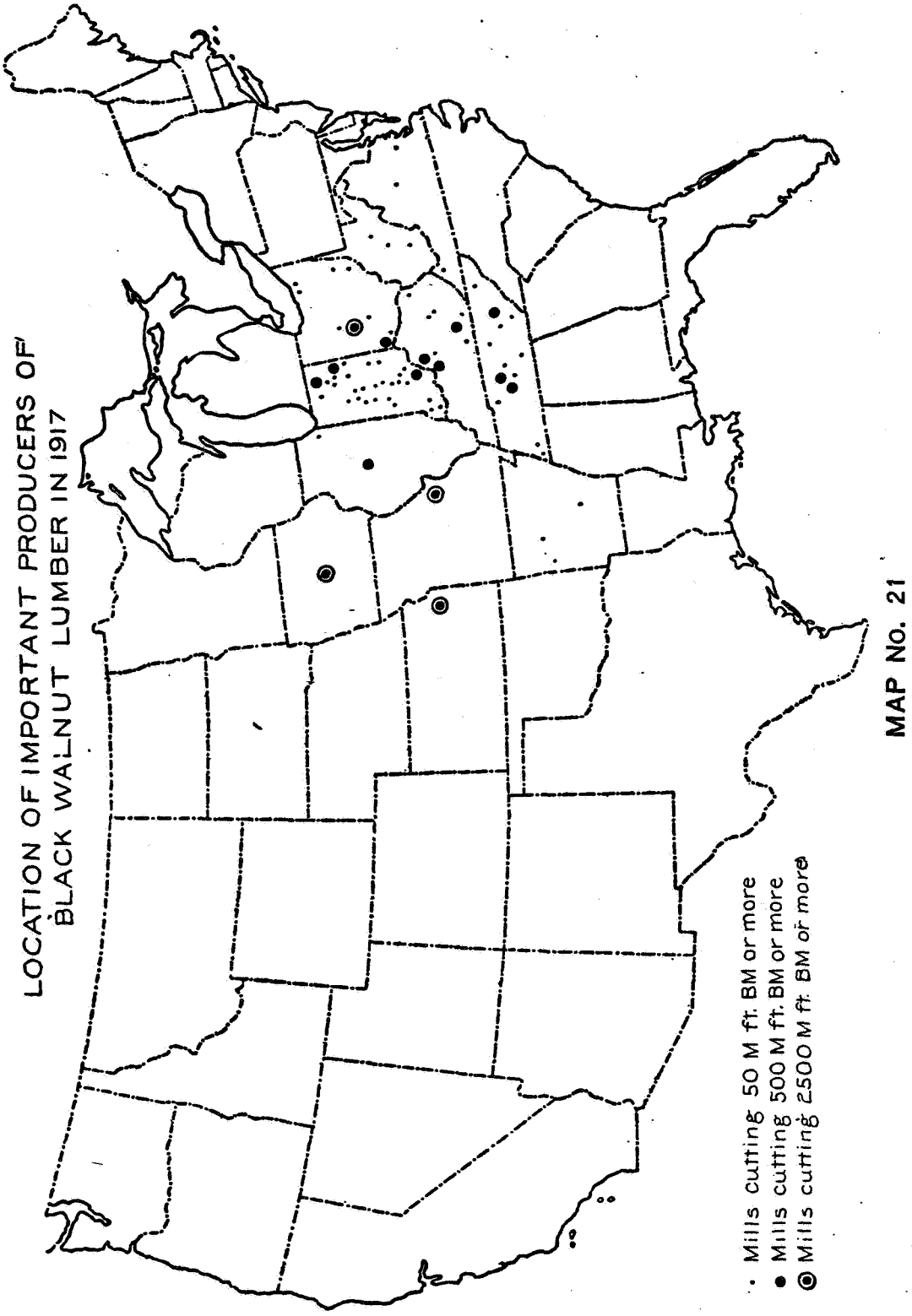
Yellow poplar is sold in large quantities in the Central and Northeastern States, where most of the wood-using industries are located. Considerable quantities are normally exported to the countries of western Europe, in whose markets American yellow poplar is a standard wood.

BLACK WALNUT.

(*Juglans nigra.*)

DISTRIBUTION.

Black walnut occurs from southern New England to southern Ontario, southern Minnesota, and south to eastern Texas and Florida. It reaches its best development and is found in largest quantities in the central woodlot region centering in Ohio, Indiana, Illinois, eastern Iowa, Missouri, Kentucky, Tennessee, and West Virginia. It has also been planted to some extent beyond its natural range. The small quantities, limited distribution, and habits of growth of the other black walnut species, the Mexican and California walnuts, render them of no importance as a source of airplane material.


LOCATION OF IMPORTANT PRODUCERS OF BLACK WALNUT LUMBER IN 1917
· Mills cutting 50 M ft. BM or more
● Mills cutting 500 M ft. BM or more
◉ Mills cutting 2500 M ft. BM or more
MAP No. 21

USE IN AIRCRAFT.

Black walnut makes the best propellers of any native species. It is easy to work, finishes well, is very resistant to wear and to shocks, and retains its place remarkably well. It also makes excellent facing plywood, both flat and bent.

While, on account of the scarcity of the remaining high-grade walnut and its consequent high price, other woods may in the future come to be used much more for propellers, it is likely that walnut will always be an important wood for this purpose.

SUPPLY OF TIMBER.

Walnut has been in demand for many years for furniture, veneers, cabinet work, and gunstocks, and the once large supply was already greatly reduced prior to 1914. Since that year, and particularly since 1917, the enormous demand for walnut for war uses has made serious inroads on the remaining accessible supply.

It occurs scattered singly through stands of mixed hardwoods, and is a very common field or roadside tree in the region of its best development. The cut in recent years has probably come largely from trees grown in the open or in groves. The best trees are found in fairly rich agricultural soil, where they grow somewhat rapidly and reach large size. The average trees that remain in the more Northern States are somewhat smaller than those in the States farther south, but are of better quality. Eighty per cent of the logs now cut run between 12 and 20 inches in diameter at the small end. The open-grown walnut timber is, of course, practically all accessible, but a large part of that grown in the forest is some distance back from roads and not easy to get at.

Estimates of the existing stand of walnut are very unsatisfactory and differ widely. The best available figures, which probably do not allow for the greatly stimulated cut during the past two or three years, indicate a stand of about 850 million board feet. The eight States, Missouri, Illinois, Tennessee, Kentucky, Ohio, Arkansas, and Indiana, have about 70 per cent of the total stand. The entire amount is distributed about as follows: Central woodlot region, 550 million feet; southern Appalachian region, 200 million feet; Gulf and Atlantic States, 100 million feet. This estimate includes all trees over 8 inches in diameter; therefore, the stand of timber, about 16 inches in diameter and upward, that will produce airplane material, must be very much smaller. By far the greater part of the standing walnut is widely scattered and is in the hands of small holders, most of whom are farmers rather than timberland owners.

PRODUCTION OF LUMBER.

Because of the scattered distribution of walnut and its production by a large number of small mills, figures on the annual cut of lumber are probably far from complete. The average annual cut during several years prior to 1914 was about 40 million feet, besides considerable quantities cut into veneer or exported in the log. Some 13 million feet of logs were exported in 1913. After 1914, from 75 to 90 million feet a year was cut and by 1918 a much larger amount had been reached. It is probable that the production of walnut lumber will soon fall back to the prewar figure or considerably below it. Indeed, this must happen unless the supply of timber is much larger than the most optimistic estimates have allowed.

Some 200 mills normally cut walnut lumber along with other woods. Only about a dozen mills ordinarily specialize on walnut to the exclusion of other species, and these probably cut nearly half of the total. Walnut mills draw on wide sections of country for their log supply, and have to maintain considerable forces of buyers to locate, purchase, and assemble the logs at shipping points. Logs are often shipped 300 miles to the mill.

Walnut lumber intended for ordinary commercial uses is generally plain sawed in order to bring out the grain, and no particular attempt is made to saw straight-grained material. All important producers are now entirely familiar with sawing airplane material, and may be expected to continue to saw it if there is a sufficient demand for such material at prices that will attract them.

It is estimated that on the average about 18 per cent of the log scale is suitable for propeller stock, considering only logs 12 inches and upward in diameter. At certain mills the proportion runs considerably higher. In some instances this is due to greater care being exercised in selecting logs for purchase, and in others to the better average quality of the walnut that is grown in the North. It seems likely that with the return of normal conditions the quality of logs obtained will tend to deteriorate, or else the cut will fall very much below the figures at which it stood in recent years.

MARKETS AND USES FOR THE LUMBER.

Black walnut has long been valued for cabinet-making and for gunstocks. It is normally employed in large quantities in the manufacture of sewing machines, musical instruments, furniture, interior finish and fixtures, and for many lesser uses. It is widely utilized in the

wood-manufacturing centers of the United States, and for many years previous to the war was exported, mostly in the log. The greater part of walnut exports formerly went to Germany, and considerable quantities to Great Britain. During the war large quantities of propeller and gunstock material were sent to the allied countries, particularly France and Great Britain.

COTTONWOOD.

COMMON COTTONWOOD (*Populus deltoides*)

This species is also known as big cottonwood, yellow cottonwood, and Carolina poplar.

SWAMP COTTONWOOD (*Populus heterophylla*)

This species is also known as black cottonwood, river cottonwood, and swamp poplar.

These two species are the most abundant and furnish the bulk of the cut. Small amounts of various species, including Balm of Gilead, narrow-leaf cottonwood, black cottonwood (western), aspen, and others, are also cut.

DISTRIBUTION.

The common cottonwood occurs over practically the entire United States east of the Rocky Mountains, except in the extreme Northeast and in southern Florida. The swamp cottonwood is largely confined to the Coastal Plain from Connecticut to western Louisiana, and up the Mississippi valley to southern Illinois and Indiana. The optimum region for both is the valley of the lower Mississippi with its tributary streams.

USE IN AIRCRAFT.

Cottonwood is low in its strength properties, but is light, tough, and fairly easy to work. Furthermore, it is cheap, fairly abundant, and accessible. It has been employed to some extent for plywood cores, in aircraft construction, and its use for this purpose may be considerably extended.

SUPPLY OF TIMBER.

The greater portion of the cottonwood lumber cut is from the common cottonwood. It is found principally along streams and often in pure stands or mixed with willows over small areas. Such stands are usually very open. Much of the mature cottonwood is associated with ash, soft maple, sycamore, red gum, tupelo, cypress, oaks, and other hardwoods, in mixed stands. In the lower Mississippi valley the trees reach large size, with diameters of from 4 to 6 feet and heights between 125 and 175 feet. Growth is extremely rapid and yields per acre are relatively large. The swamp cottonwood grows in similar situations and is cut along with the common cottonwood.

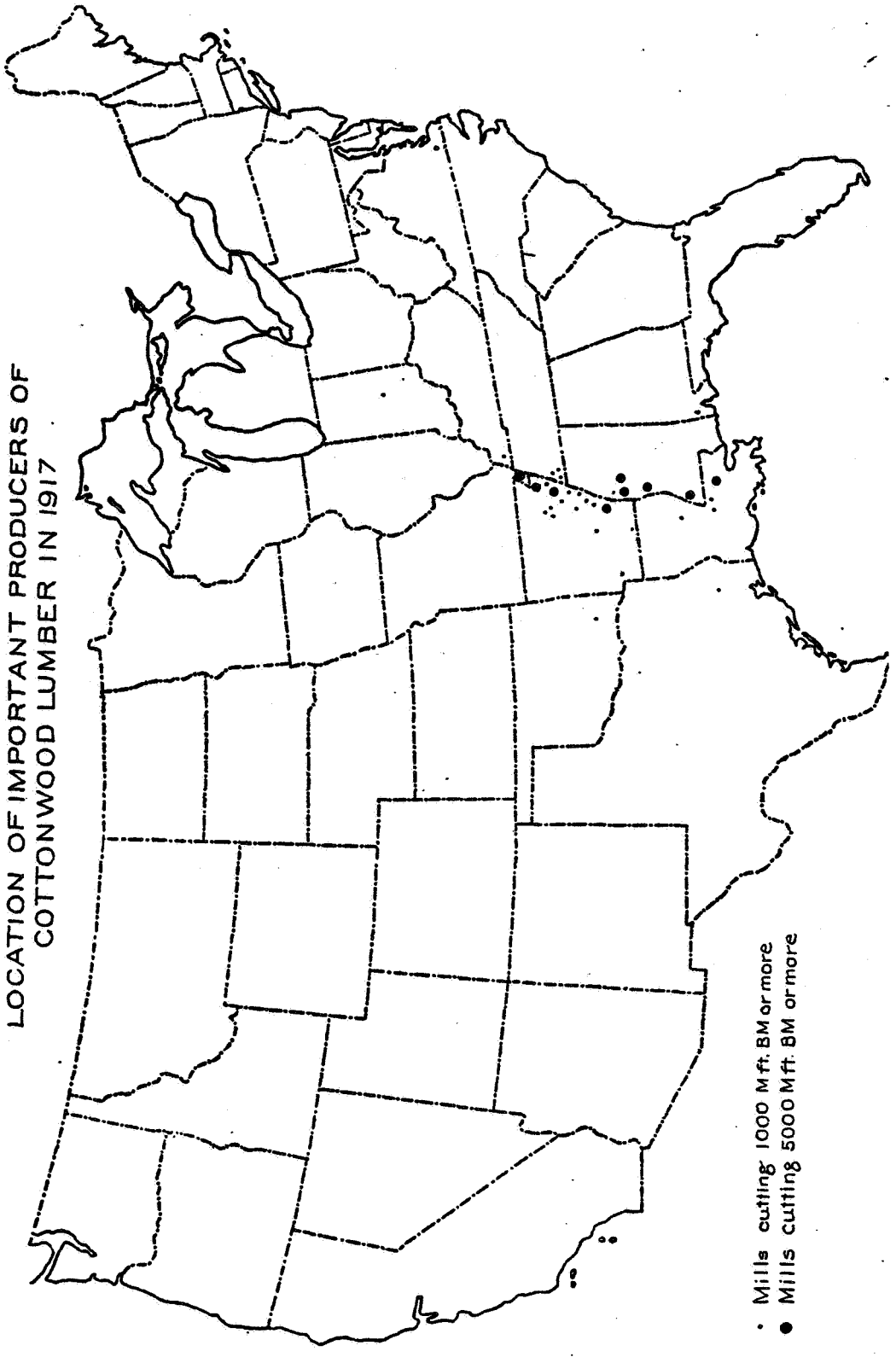
The available estimates of the stand of cottonwood are very rough and unsatisfactory. It has been judged that there is approximately 10 billion board feet in trees above 8 inches in diameter. Two-thirds of it is in Arkansas, Louisiana, Missouri, Mississippi, and Oklahoma. More than three-fourths is in the lower Mississippi valley region, a little more than a billion feet in the Coastal Plain region, and possibly three-fourths billion feet in the Great Lakes region. Most of the extensive stands of the Mississippi region are owned by large lumber companies. The cottonwood in Kansas, Iowa, Minnesota, Illinois, and Indiana is mostly in planted groves and owned in small units by farmers and others

PRODUCTION OF LUMBER.

The average annual cut of cottonwood lumber in the United States between 1913 and 1917 was 195 million board feet, which is nearly 50 million feet less than the average cut during the preceding six years. In addition, large amounts of cottonwood are cut into veneer, excelsior, and pulpwood. The cut is gradually decreasing, which indicates that the supply of standing timber is probably becoming limited. Considering the rapid growth of cottonwood, however, it would seem that the present rate of cutting might be maintained almost indefinitely if the forests are carefully handled.

The most important cottonwood-producing State is Mississippi, which cuts more than one-fourth of the total. A close second is Arkansas, followed by Louisiana, Minnesota, and Missouri. These five States cut about three-fourths of the total. The cut in Minnesota is chiefly aspen and Balm of Gilead, and no mill in that State reports a cut in excess of a million board feet of cottonwood. In the South, 27 mills reported for 1917 cuts of between 1 and 5 million feet, and 9 mills reported cuts in excess of 5 million feet.

Cottonwood, together with associated species, is logged to stream banks, usually by animals, and from there it is usually towed on barges or in rafts to the mills, which are often many miles


LOCATION OF IMPORTANT PRODUCERS OF COTTONWOOD LUMBER IN 1917
MAP No. 22
· Mills cutting 1000 M ft. BM or more
● Mills cutting 5000 M ft. BM or more

distant. Logging operations proceed throughout the year, except as they may be interfered with by floods. The lumber that might be used for aircraft will come largely from material graded as wagon-box boards and firsts and seconds. The proportion of these grades in the lumber cut varies from about 25 per cent in comparatively young stands to 40 or 50 per cent in old stands of large timber. These figures apply to the lower Mississippi valley cottonwood only; the proportion is probably smaller in the stands farther to the north.

MARKETS AND USES FOR THE LUMBER.

Practically the entire cut of cottonwood lumber is further manufactured. Cottonwood is in great demand for boxes and crates, and nearly two-thirds of the lumber cut is used by this industry. The vehicle industry uses about 10 per cent of the cut, chiefly for wagon-box boards, which requre high-grade material. Slightly more than 6 per cent goes into planing-mill products, 5 per cent into agricultural implements, 4 per cent into woodenware, nearly 3 per cent into laundry appliances, about 2 per cent into furniture. Refrigerators, trunks, railroad cars, musical instruments, and fixtures take considerable quantities. Cottonwood veneer in the form of plywood is widely used for furniture, musical instruments, and similar uses. A great deal of cottonwood not reported in the lumber cut figures goes into excelsior, and a large amount is made into pulp for paper manufacture.

Cottonwood is used throughout most of the United States, and considerable quantities of plywood made from it were shipped to Europe before the war.

RED GUM.

(*Liquidambar styraciflua.*)

This species is also known as satin walnut, sweet gum, and liquidambar.

DISTRIBUTION.

Red gum occurs from southern Connecticut to southeastern Missouri and south to Texas and Florida. It reaches its best development and is most abundant in the lower Mississippi valley, from the mouth of the Ohio River southward.

USE IN AIRCRAFT.

Red gum is an excellent material for the manufacture of plywood, and is so used to a very great extent for commercial purposes. Its use has been approved for airplane plywood. The large and fairly accessible supply of this species makes it a promising wood for future use in the aircraft industry.

SUPPLY OF TIMBER.

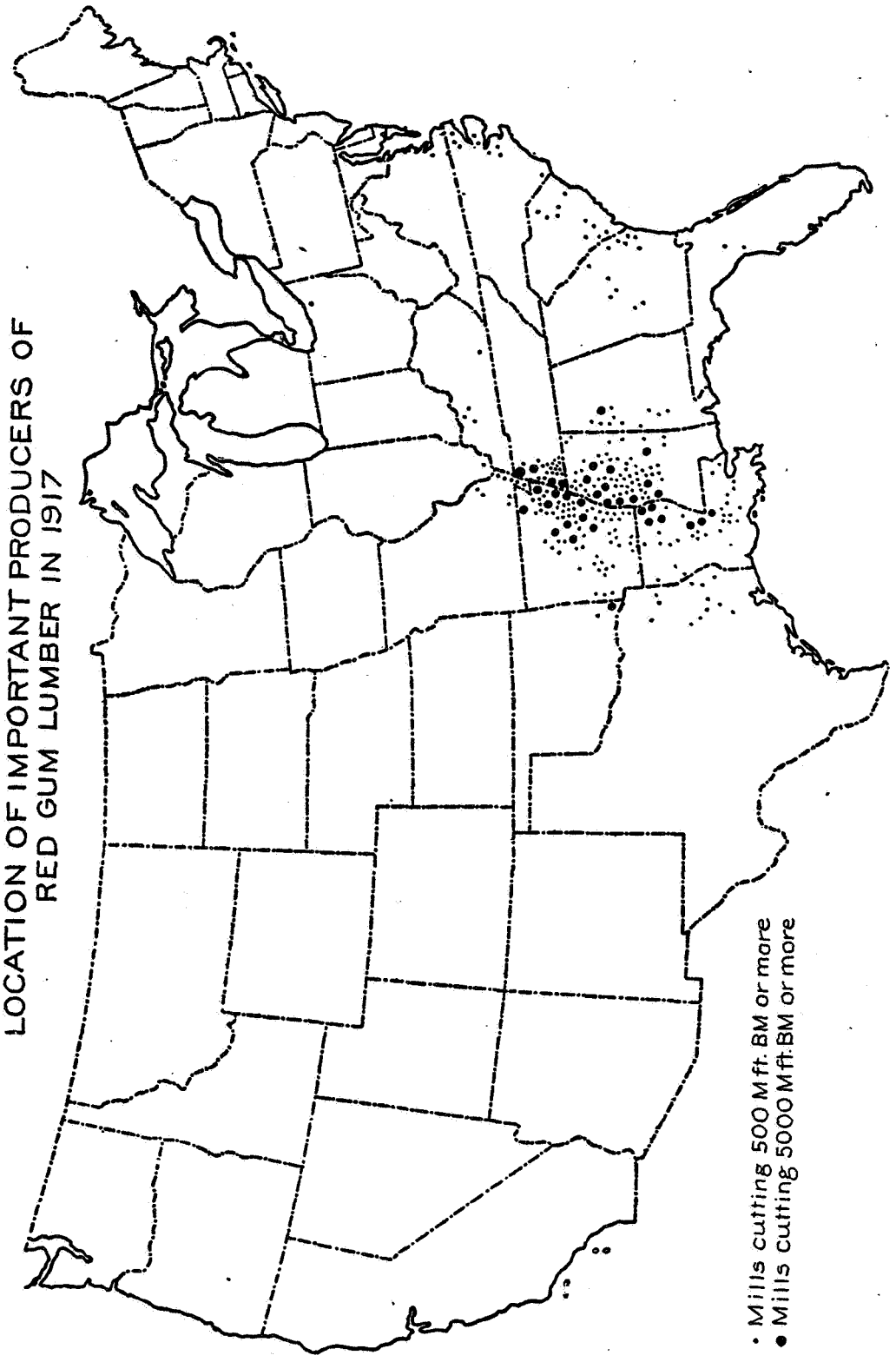
Such incomplete estimates as are available indicate a total stand of red gum of approximately 44 billion board feet; of this amount 30 billion feet is in the Mississippi Valley, including tributary streams, and 14 billion feet is in the Atlantic and Gulf Coastal Plain region. The States having the largest supplies are, in the order named: Mississippi, Arkansas, Louisiana, Texas, Alabama, Georgia, South Carolina, and North Carolina. These States together have about 80 per cent of the total.

Although limited areas of young stands are occasionally found, red gum usually occurs scattered through mixed hardwood stands. It grows chiefly on bottom lands more or less subject to overflow during part of the year. Its associates include such species as cottonwood, soft maple, ash, tupelo, oaks, pecan, cypress, and sycamore. The gum is frequently the predominant species. Mature trees often reach diameters of 4 or 5 feet or even more.

The greater part of the remaining stand of mature gum is owned by large land and lumber companies. Since the gum land will for the most part be suitable for agriculture when drained, it seems probable that the supply of timber when once removed will never be renewed in anything like the original quantity.

PRODUCTION OF LUMBER.

The average annual cut of red gum lumber between 1913 and 1917 was 740 million feet, or about 100 million feet more than the average cut during the preceding six years. In 1917 it was about 790 million feet. Production of this species will probably not fall below the present figure for several years. The figures given do not include the large amounts cut for veneer. In 1910 and 1911, the last years for which reports on that product are available, nearly 150 million feet, log scale, of red gum was cut into veneer, practically all by the rotary process. About 35 mills reported for 1917 cuts of red gum in excess of 5 million feet each. All of these


LOCATION OF IMPORTANT PRODUCERS OF RED GUM LUMBER IN 1917
• Mills cutting 500 M ft. BM or more
● Mills cutting 5000 M ft. BM or more
MAP No. 23

are in the lower Mississippi region. About 200 mills in this region and 35 in the Atlantic coast region reported cuts of between 500 thousand and 5 million board feet. Arkansas leads in the production of red gum, and is followed by Mississippi and Louisiana. These three States cut about two-thirds of the total.

Logs are generally cut in the fall and allowed to season somewhat before being towed out on rafts or barges. A few operators in drier territory have railroads and use steam in logging. Usually only the larger trees are cut, since small trees contain a large proportion of sapwood, which brings comparatively low prices.

It is estimated that from 20 to 25 per cent of the cut in the Mississippi region is firsts and seconds clear heart, while in the coast region not more than from 5 to 8 per cent is of this grade. Clear sap runs about 25 per cent in the valley States and 32 per cent on the coast. Material suitable for aircraft veneer would probably correspond to these two grades.

MARKETS AND USES FOR THE LUMBER.

A very large proportion of the clear heart gum used to be exported to the countries of western Europe and around the Mediterranean, where it is in great favor for furniture and finish. Practically all of the rest is used in industries in this country, almost none being consumed as rough lumber.

Approximately half of the lumber and veneer used in this country is made into boxes and crates. The quantity of red gum used by this industry is surpassed only by that of white and yellow pines. Fifteen per cent is used for planing-mill products, chiefly finish. Thirteen per cent goes into furniture, 3 per cent into vehicles (wagon boxes), 2½ per cent into sewing machines, and smaller quantities into a great variety of industries.

MAHOGANY.

CENTRAL AMERICAN MAHOGANY (*Swietenia mahagoni* and *S. macrophylla*).

AFRICAN MAHOGANY (*Khaya senegalensis*).

Numerous other species of Khaya, Entandrophragma, Trichilia, and other genera are also sold as African mahogany.

PHILIPPINE MAHOGANY (*Shorea polysperma*).

This species is also sold under the name of Tanguile or Bataan mahogany. Red Lauan (*S. negrosensis*) is sometimes called Philippine mahogany.

DISTRIBUTION.

True mahogany (the American species) occurs from southern Florida to Colombia, Venezuela, and British Guiana. It is most abundant in southern Mexico (Vera Cruz, Tabasco, Campeche, and Chiapas districts), in Central America, and in the larger islands of the West Indies.

African mahogany is found in the forest belt of the west coast of Africa from the Senegal River to the southern boundary of Angola, and across central Africa to German East Africa and Madagascar. The largest supplies are in a belt varying in width from a few miles up to 200 miles, from the Senegal River to the Niger, and in a narrower strip from southern Nigeria to the northern part of French Congo. The best species, *Khaya senegalensis*, is nearly all between the Senegal and the Niger, although it is scattered to some extent in the forests of East Africa.

The so-called Philippine mahoganies occur in the Philippines and in neighboring parts of Malaysia.

USE IN AIRCRAFT.

The true mahogany is a most excellent propeller wood, and has been very extensively used for that purpose. Selected pieces of African mahogany are as satisfactory as the true mahogany, but on account of the wide variation in strength properties between the different species and between different lots of lumber from the same species, together with the difficulties in distinguishing the different species by inspection, African mahogany has not been popular as a propeller wood. The Bataan mahogany from the Philippines has also found a limited use for propellers.

Both the American and the African mahoganies make excellent plywood, but will hardly be used for that purpose on a large scale because of their high cost as compared with native woods which are quite as satisfactory.

SUPPLY OF TIMBER.

hogany occurs as a scattered tree in dense tropical forests, which are composed of a number of species. This is equally true of the Central American and the African e supplies of standing timber are very little known except in the regions which ed for years.

The total stand of true mahogany in Central America and Mexico has been roughly estimated at 19 billion 450 million board feet, and that in Cuba at 750 million board feet. Of this, about one-third is available to present operations; the rest can be reached only by the construction of railroads or by the introduction of different methods of logging. Mexico has 15 billion feet, Honduras 1¾ billion feet, Nicaragua 1½ billion feet, Guatemala three-fourths of a billion feet, Costa Rica one-fourth of a billion feet, and Panama and British Honduras 100 million feet each. Information is not available regarding the supplies in the West Indies, with the exception of Cuba, or in South America. The true mahogany reaches diameters of from 4 to 6 feet and heights of 100 feet or more. The logs which are produced now do not average as large as did those produced earlier, because the best of the accessible timber has been removed.

Almost nothing is known regarding the stand of African mahogany, except that, as compared with the present consumption, the supply is almost unlimited. The largest quantities of Senegal mahogany are in the Liberia, Ivory Coast, and Gold Coast territories, while there are large amounts of other species in Kamerun, French Congo, Lagos, southern Nigeria, Spanish Guinea, and smaller amounts in Senegal, Sierra Leone, Angola, Belgian Congo, and Madagascar. African mahogany trees are very large, so that 4 or 5 foot squared logs are common.

The supply of Philippine mahogany (Bataan) available to the larger existing plants is estimated at about 5,400 million board feet.

PRODUCTION OF LUMBER.

Almost all of the Central American and African mahogany cut is exported from the producing countries. Most of it is shipped in the log or hewed into square timbers. Logs are cut by natives, who work either for contractors or directly for the mahogany firms, and the production varies considerably from year to year, depending upon markets, weather conditions (particularly in Central America, where the mahogany logs are taken down to the coast by river floods), and other factors. Logging operations are usually carried on almost entirely by hand labor. A few large concerns use steam or gasoline tractors to haul their logs, but in most operations even the largest logs are pulled to the streams by natives.

The exports of mahogany from South and Central America and the West Indies in 1913, which was a fairly representative year, amounted approximately to 100 million tons or about 50 million board feet. Of this amount the United States used about half, Great Britain about 35 per cent (including that reexported from the United States), and France nearly all of the remainder. The exports of African mahogany in the same year amounted to about 150 million tons, or 75 million board feet, of which about two-thirds went to Great Britain, one-seventh to the United States, and the rest was about equally divided between France and Germany. Liverpool is the great mahogany market of the world, and much of the mahogany which goes there is reexported. In 1913, the United States imported some 21 million board feet of mahogany from Great Britain. This was doubtless principally African mahogany from Liverpool.

The importation of mahogany into the United States is largely controlled by a few companies. The amount of lumber sawed in this country varies considerably from year to year, but for the past five or six years the reported cut has averaged between 20 and 25 million board feet. This may be somewhat less than the actual total cut. Leading States in the production of mahogany lumber are Louisiana (New Orleans), Kentucky (Louisville), Indiana (Indianapolis), Illinois (Chicago), Ohio, and California. From 28 to 42 per cent of the Central American mahogany that is imported is suitable for propellers. The proportion of African mahogany that might be so used can not be estimated, because the character of the timber that may be received is uncertain.

USES FOR THE LUMBER.

Before the war, about 50 million feet of mahogany was used each year in the United States. Thirty-six per cent of this was used for furniture, 17 per cent for musical instruments, 15 per cent for interior finish, 12 per cent for car finish, 11 per cent for fixtures, 3 per cent for caskets and coffins, 2 per cent for ship and boat finish, and small quantities for various other purposes.

SPANISH CEDAR.

(*Cedrela odorata.*)

This species is also called Indian mahogany.

DISTRIBUTION.

Spanish cedar occurs form Tampico, Mexico, southward to Brazil, and through the West Indies. A closely related species, the toona or cedar mahogany (*Cedrela toona*), grows in the East Indies.

USE IN AIRCRAFT.

Spanish cedar, being light, durable, easily worked, and strong for its weight, makes excellent ply wood, and has been used to a considerable extent for thin planking for flying boats and floats.

SUPPLY OF TIMBER.

This species occurs in about the same situations as mahogany, with which it is associated in the range of the latter. It is scattered through mixed stands, but is probably somewhat more abundant than the mahogany. Cedar trees reach great size, diameters up to 6 feet being not uncommon. Information is not available regarding the amount of standing cedar except that it is known to be large.

PRODUCTION OF LUMBER.

Spanish cedar is frequently cut in connection with mahogany. Cedar logs are often used in rafts to help keep the heavier mahogany logs afloat. Considerable quantities of cedar are logged independently. Data on the total production of Spanish cedar are not at hand. From 15 to 20 million feet is imported in the log into the United States in normal years, while the imports of sawed lumber, chiefly from Cuba, are estimated at about 10 million feet a year. Large quantities go also to Liverpool, London, and Hamburg. Since only selected material is usually imported, a very large proportion of it would be suitable for use in aircraft. Our largest imports are from Cuba. Other countries which supply considerable quanties are Brazil, Mexico, British Honduras, Colombia, Nicaragua, Costa Rica, Panama, and Dutch Guiana.

USES FOR THE LUMBER.

Almost the entire output of Spanish cedar is normally made into cigar boxes. In the United States more than 99 per cent of the cedar used goes to that industry.

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